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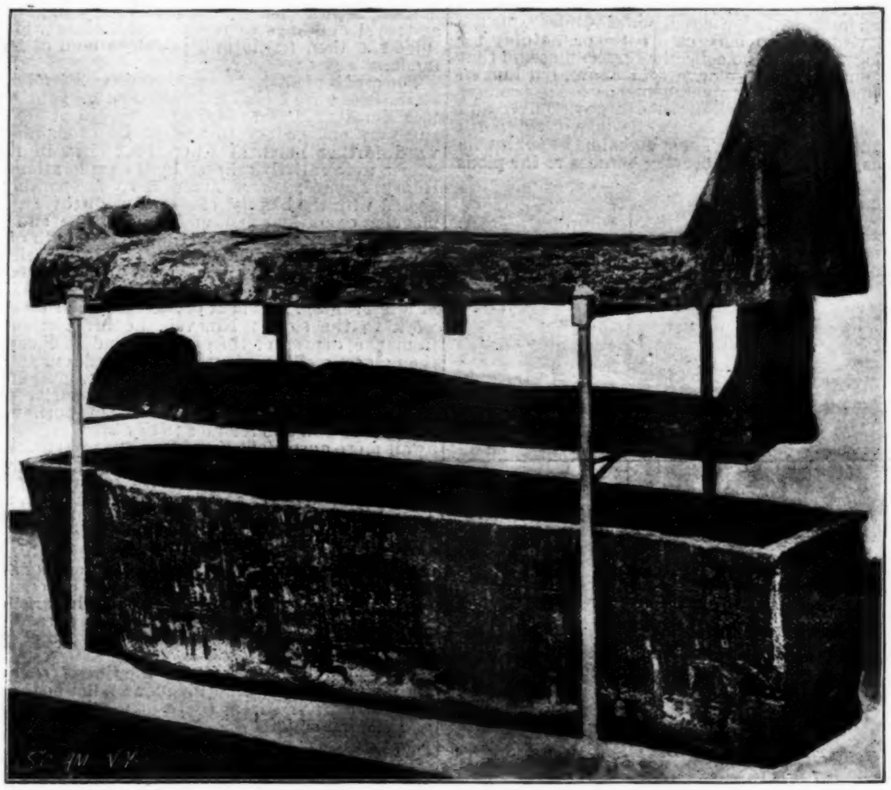
THE BRITISH MUSEUM.

By Sir E. MAUNDE THOMPSON, K.C.B., in Leisure Hour.

THE DEPARTMENT OF EGYPTIAN AND ASSYRIAN ANTIQUITIES.

UNLIKE the Greek and Roman antiquities, which, as we have seen, owed so much to the incorporation of several independent collections, the collection of Egyptian antiquities in the British Museum has grown round one great nucleus—namely, the splendid series of sculptures and other remains which were brought together in Alexandria by the Institute of Egypt, a learned body which was founded under the auspices of Napoleon Bonaparte. After the capitulation of that city in 1801 the antiquities became the prize of the British army, and were forthwith brought to England, and were deposited in the British Museum in the following year. Since that date the collection has steadily grown; and gifts, bequests, and purchases have contributed to make it one of the finest and most complete. When we remember that barely three-quarters of a century has elapsed since the inscriptions on the Egyptian monuments and papyri were first deciphered, the progress made in our knowledge of the early history of the country and of the manners and customs of its ancient inhabitants is astonishing. And such rapid progress is only possible when the country whose history we are studying yields such abundant remains of bygone ages as does Egypt. Passing through the Egyptian galleries, which extend the whole length of the western side of the museum on the ground floor, we have before us a series of sculptures which illustrate the history of Egypt in most of its known periods, commencing with that of the great pyramid-building Pharaohs, who held sway between three and four thousand years before Christ. Of the more remote times the remains are naturally limited in number; but of the great period of Egypt's prosperity, under the conquering kings of the eighteenth dynasty, from 1700 to 1400 B. C., there are many interesting monuments; and from this date the series is fairly complete, illustrating well the time of the oppression of the children of Israel, when the powerful monarch Rameses II reigned in the land, and passing on through the troubled epochs of Egypt's captivity and decadence, and ending with the times when she was ruled successively by Greek and Roman masters.

Perhaps the most striking fact in regard to Egyptian sculpture is that, in its earliest stages, as we see it in the surviving monuments, it is more faithful to nature than in its later development. The human figure is modeled upon the living shape; not upon conventional ideas. We only have to look at such a figure as that of the wooden statue which was found not

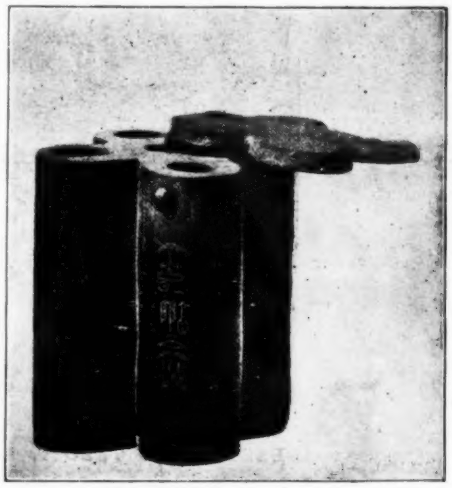


COFFINS OF AN EGYPTIAN PRIESTESS.

Outer and inner coffins, together with a case which covered the mummy, of wood brilliantly painted and decorated with mythological scenes and religious emblems and inscriptions. They were used for the burial of a priestess named Thent-hen-f, of the confraternity of Amen at Thebes, about 900 B. C. But the inner coffin was originally made for a priest, whose name on it has been erased.

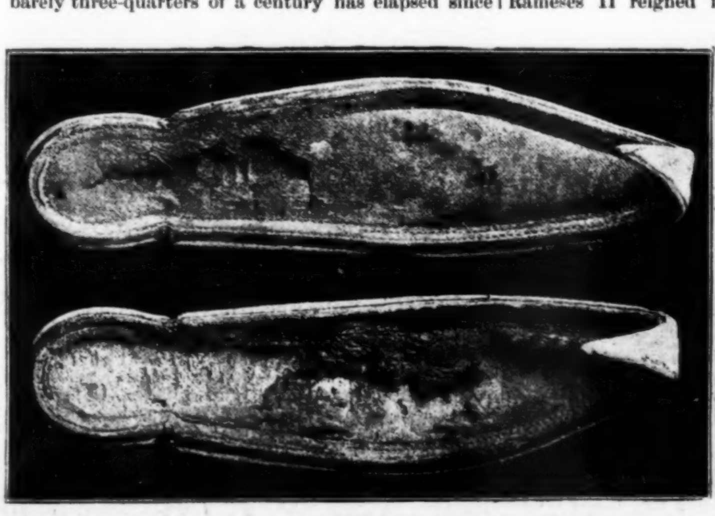
Alabaster Pot of Ointment.

Comb.



Box for Antimony or Bismuth for coloring the eyelids, the material in the several tubes being appropriate for different seasons.

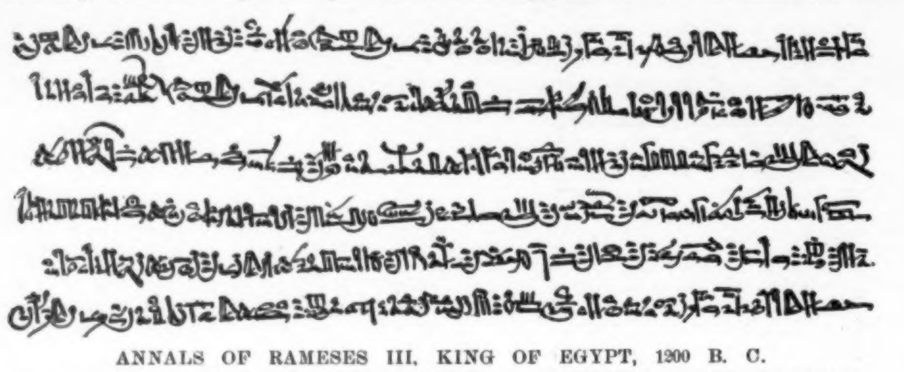
AN EGYPTIAN LADY'S TOILET ARTICLES.



EGYPTIAN LADY'S SLIPPERS, NECKLACE AND PINS, AND BRONZE MIRROR.

many years ago, and which, from its likeness to the chief official of the place, was called by the natives the Shekh el-Beled, or "mayor of the town," and we have before us the life like image of a well-to-do farmer or landowner of more than five thousand years ago as he walked in his fields and surveyed his crops or counted his cattle; and, knowing that such perfection in rendering nature is not attained by nations in their infancy, we are naturally led to speculate on the numbers of generations that must have passed away before the Egyptians of that remote period could have attained to such artistic skill. Later in their history we see this earlier striving after nature crippled by conventional feeling, and the statues of their gods and kings are sculptured in that stiff and monotonous attitude which we know so well that we regard it as typically Egyptian, but which, notwithstanding, seldom fails to impress us with a solemn grandeur. Later still we come to a period when this grander style gives place to one of a more decorative character, marked by elaborate finish and delicate workmanship.

Conspicuous at the end of the series of sculptures is the Rosetta Stone, which afforded the clew to the decipherment of the hieroglyphic characters, and eventually unfolded the historical records and the religious texts and literature of this ancient people. On this stone, which gets its name from having been found in 1798 near the Rosetta mouth of the Nile, is inscribed a decree of the priests of Memphis conferring divine honors on Ptolemy Epiphanes, king of Egypt, and dated in the year 195 B. C. The inscription is in three forms—viz., in the Egyptian language in hieroglyphics or writing of the priests; in the same language in demotic, or writing of the people; and in the Greek language and character. By means of the Greek text the names of kings, which in the hieroglyphics are inclosed in oblong rings or "cartouches," were dissected, and the Egyptian characters of which they are composed were identified. Thomas Young thus succeeded, in 1818, in fixing the value of some nine signs; four years later the French scholar Champollion was able to publish a complete system of decipherment.



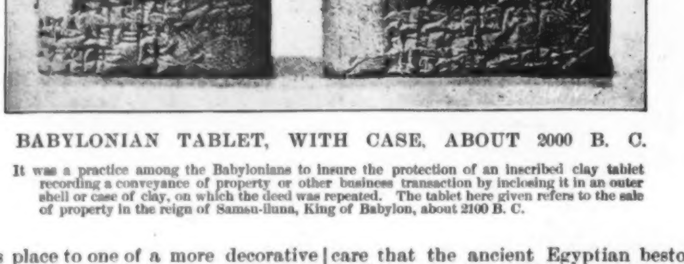
ANNALS OF RAMESES III, KING OF EGYPT, 1200 B. C.

The papyrus from which these few lines are copied is inscribed with a long account of the deeds of Rameses III, in the hieratic character of Egyptian writing. The king here enumerates the benefits conferred by him upon the country: "I made the whole land to be grown with trees in full leaf, and I made the people to sit beneath their shade. Through me did the woman of Egypt walk with bold and fearless steps whithersoever she would, without molestation by the way."

The Egyptian collection of smaller objects, which are gathered in the upper rooms of the museum, are of no less interest than the sculptures—indeed, for the general visitor, who may care little or nothing for archæology, there is no collection in the museum that is so fascinating. As we have said above, our human sympathies are here keenly touched; we are brought into close contact with fellow creatures who lived and moved and had their being on the face of this earth thousands of years ago. Their embalmed remains lie before us in solemn rows, bearing witness to the pious care that the ancient Egyptian bestowed upon the dead, in order to prevent the corruption of the body, which was some day again to be the dwelling place of the immortal soul. We see the coffin in which the body was laid, with its inscriptions of prayers and images of the protecting gods; the great liturgy, or "Book of the Dead," with its psalms, and confessions, and prayers, which in beauty of language and ideas may compare not unfavorably with those of more modern nations; the little figures which, sometimes in scores, were laid with the body, and were ready to plow and sow and reap for the dead man when he came to the Fields of the Blessed; the jars in which his heart and vital parts lay embalmed under the protection of special deities; the amulets which protected him from the powers of darkness; the vessels, often of costly material, in which he would find food and unguents when he needed them; the implements which he used in his lifetime—his ax, or knife, or other tools, musical instruments, writing materials, and what not; jewelry that adorned his body or his wife's; his razor and her toilet furniture, the very piece of pumice stone which served as her nail brush, and the pair of slippers which she wore; the toys of their children—in a word, scarcely anything is wanting to fill in the outline of the domestic life of ancient Egypt. And not a few of these objects are beautiful works of art. The shapes and material of the fine series of alabaster vessels and the delicate workmanship and brilliant coloring of many of the specimens of porcelain are most attractive. Many among the long lines of statues and statuettes of gods and men are finely modeled; and different objects in metal, whether they be pieces of jewelry or figures or vessels, are worked with wonderful artistic skill. Nor must we forget the great series of papyri, those books of the ancient Egyptians made in the form of long rolls from material supplied by the prolific papyrus plant, inscribed with their literature, both sacred and profane. It is a significant commentary on the text of the vanity of human wishes to find in the oldest known Egyptian papyrus, estimated to have been written some two thousand five hundred years before Christ—and that, too, only a copy of a more ancient text—mournful laments on the brevity of man's mortal life and happiness.

BABYLONIAN TABLET, WITH CASE, ABOUT 2000 B. C.

It was a practice among the Babylonians to insure the protection of an inscribed clay tablet recording a conveyance of property or other business transaction by inclosing it in an outer shell or case of clay, on which the deed was repeated. The tablet here given refers to the sale of property in the reign of Samsu-iluna, King of Babylon, about 2100 B. C.



CLAY CYLINDER OF NEBUCHADNEZZAR, KING OF BABYLON, 604–562 B. C.

Inscribed in cuneiform characters, with an account of the building of temples and of the walls of Babylon.

ASSYRIAN ANTIQUITIES.

Little more than half a century ago the ancient kingdoms of Babylonia and Assyria were but a name. Along the lower course of the Euphrates and higher up the stream of the Tigris a series of sand-covered mounds alone indicated the sites of the mighty cities and royal buildings of the powerful races which had ruled the then fertile and populous land of Mesopotamia.

The credit of first attempting systematically to explore these buried remains is due to a Frenchman. In 1842 Monsieur Botta, the French consul at Mosul, began work on the site of ancient Nineveh, and afterward farther north at Khorsabad. But in 1845 his efforts were entirely eclipsed by the explorations of Sir Henry Layard, whose name is so inseparably connected with the history of Assyrian discovery. Commencing operations first at Nimroud, the site of the ancient Calah of Genesis, lying to the south of Nineveh, he unearthed the palaces of Ashur-nasir-pal, a king of Assyria who reigned nearly nine hundred years before Christ, of his successor, Shalmaneser II, and of a later king, Esarhaddon. Then, transferring the work to the site of Nineveh, he brought to light, from the depths of the great mound of Kouyunjik, the palaces of Sennacherib, of Esarhaddon, and of his son Ashur-bani-pal, whose reigns covered the period 705–626 B. C. Since Layard's day successive excavations have made a fair clearance of this portion of the site; but much still remains to be discovered and must await more auspicious times than the present. Various other sites in the ancient kingdom of Assyria have also been explored. In the still earlier kingdom of Babylonia such sites as Nipur, Erech, Ellasar, and Ur of the Chaldees have been partially attempted, and within the circuit of the walls of ancient Babylon itself important discoveries were made by Sir Henry Rawlinson. With the more recent explorations undertaken by other nations we are not here concerned. It was chiefly the early discoveries which enriched the British Museum with the remarkable series of sculptures and other remains of the two great peoples of Western Asia.

It will be remembered that the tide of conquest of the first founders of these kingdoms followed the course of the great rivers from south to north; that the old Babylonian empire was first consolidated along the lower waters of the Euphrates; that thence it pushed its way northward along the course of the Tigris; and that in process of time a second empire grew up in the northern land, and at length became the independent kingdom of Assyria, destined to become more powerful than the parent stock, and even to hold Babylonia in subjection. But we need not here pursue the history of the two kingdoms. From what has been said it will be inferred that the remains which have been recovered from Assyria will prove to be those of a people more advanced in the arts of civilization than the remains which have been yielded up by the more ancient cities of Babylonia. This is the fact. The collections of Babylonian antiquities in the British Museum consist for the most part of very early and rudely sculptured statues, statuettes, and bronzes, votive offerings, boundary stones, etc., and small objects of various kinds, including numerous inscribed tablets; while those of Assyrian origin—besides innumerable smaller objects, many of them of great artistic excellence, and whole libraries of inscribed tablets—comprise bass-reliefs from the walls of palaces which are sculptured with no mean skill. No such series of sculptures exists elsewhere, nor is it probable that at any time in the future will any museum ever have the opportunity of rivaling this collection. And, apart from their archæological and artistic value, the Babylonian and Assyrian antiquities must always be regarded by us with particular interest on account of the confirmation which they afford in many instances to the Bible narrative. When we have beneath our eyes the very monument on which an Assyrian king records the submission of a king of Israel, or the very clay cylinders on which are impressed the details of campaigns of which we read in the Books of Kings, what stronger testimony could we desire?

The sculptures from different sites in Assyria occupy chiefly the galleries which lie between those containing the Egyptian and Greek collections. First, after passing the colossal winged and man-headed bulls, presiding genii which guarded the gateway of the palace of King Sargon at Khorsabad, we have spoils of the palace of Ashur-nasir-pal at Calah, great winged and human-headed lions, the sculptured slabs which lined the walls, and the statue of the king himself and the altars at which he offered sacrifice. The subjects carved in relief on the walls of the Assyrian palaces are generally scenes from war and the chase. The Calah sculptures, which are executed in broad style, also include great figures of the gods. From this site also came the famous black stone obelisk on the four sides

of which Shalmaneser II cut the account of his expeditions, and among other conquests recorded the submission of "Jehu, the son of Omri" A period of a century and a half separates the remains of Calah from those of Nineveh, and a comparison of the two series shows us how the sculptor's art developed in the valley of the Tigris. From the large broad style of Ashur-nasir-pal we pass to the more exact and carefully modeled works of the time of the kings who dwelt in Nineveh. Indeed, from the palace of Ashurbani-pal (the same whom the Greeks named Sardanapalus) have been recovered scenes from the chase which, in the anatomical treatment of animal life, disclose a faithful rendering of nature, and in the details of mere decoration exhibit a wonderful patience and accuracy of touch. A painstaking attention to such points of detail appears to have been the forte of the Assyrian artist from the earlier periods; and in the later examples from Nineveh we have put it in its most elaborate stage. But, as compared with the Greek sculptor, the Assyrian was, after all, but a mechanical workman; he never succeeded in producing artistic statues in the round, and his favorite method of presenting to us what he could do in the field of sculpture was work in low relief. As we have said, the best specimens of this work have been found in the ruins of Nineveh; but these are not all. Scenes in a less ornate and less artistic style from the same source are of great historical interest; the building of the palace of Sennacherib, the progress of his wars, and, above all, his memorable siege of Lachish (about 700 B. C.), the assault on the city and its capture, are here represented. And the reality of historical events is forcibly brought home to us when in this series of sculptures we see many of them shattered and blackened by the fire that wasted the city when it fell before the conquering arms of the Medes and Babylonians in the year 609 B. C.

But we owe more than these picture records of their reigns to the last of the Assyrian monarchs. In the royal libraries were stored up thousands of inscribed tablets—cakes of clay, the chief writing material of the nations of Western Asia, covered with cuneiform or wedge-shaped characters which were impressed with a square pointed instrument, dug obliquely into the surface—literally books, which dealt with the history, the language, the laws, the sciences, the religion, the superstitions, the manners and customs, and the affairs of life of ancient Assyria. Most interesting of all to people in general are those which have handed down to us the traditions of the Creation, and still more those which tell us of the deluge, so closely resembling the account that we read in our Bible. The greater part of the contents of these ancient libraries are now stored in safety in our museum; but, no doubt, there is much still lying in the unexplored mounds of Nineveh which a future day will bring to light. Other sites also have yielded vast stores of cuneiform records of both Assyria and Babylonia, and every day adds to the number that are being laid up, not only in the museums of Europe, but also in those of America. But the British Museum has had the advantage of being first in the field, and will probably always maintain its place in the van of all competitors.

As we have already said, the antiquities from Babylonia are generally of a more ancient and primitive character than the collection from Assyria; and those, too, which belong to the period of the later Babylonian empire, after the fall of Assyria, do not include among them objects of particular artistic merit. An exception, however, should be made with regard to the engraved seals. These were manufactured from the earliest times among the Babylonians, and were frequently worked with much skill. Their universal use, no doubt, encouraged the engravers to excel in working on the hard kinds of stones which were usually employed in their production. Being in cylinder form, they were rolled along the surface that was to receive the impression, which thus filled a comparatively large space and invited examination into the details of its design. But, above all, it is the immense age of the Babylonian antiquities that impresses us. For example, we have in the room where they are brought together a show case in which, among the objects therein exhibited, the one of most recent date is a bronze door step from a temple built by Nebuchadnezzar, while in a neighboring case are inscriptions on stone which are engraved in characters scarcely emerging from the primitive stage of picture writing.

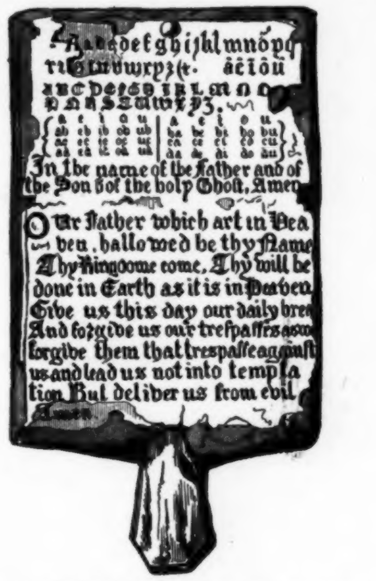
(To be continued.)

THE HISTORY OF THE HORN BOOK.*

IN these days, when education is compulsory and also free, when books for teaching children to read are so numerous and so admirably compiled, we are apt to forget that there were times, not very long ago, when books were scarce and children's primers did not exist. How were children in those times taught the alphabet? It is doubtful whether one man in ten could answer the question. The tenth might have heard of the horn book, but would have some difficulty in saying what the horn book was. This once common and —if we except the birch, more frequently used formerly than now—only means of instructing children has become so scarce as to be almost obsolete. To trace the history of this relic of bygone days must have entailed much labor and research, and Mr Andrew Tuer has spared himself no pains in gathering materials for the two handsome volumes which he has just published under the title, "History of the Horn Book," and dedicated to the Queen. He tells us in the preface that at the Caxton Exhibition in 1877 there were four horn books, and at the Loan Exhibition of the Horners' Company, held at the Mansion House in 1882, when special efforts were made to bring together as many horn books as possible, the total number shown was eight. Something like a hundred and fifty are mentioned by Mr. Tuer in his work, and he takes the opportunity to express the opinion that, unaided by the press, he would never have heard of a quarter of them. Then he goes on to say: "The writer has pestered countless people for information about the horn book. Mr. Gladstone's reply was unexpected but to the point; he said that he knew nothing at all about it." Mr. Tuer has done his work so thoroughly that his book is not only of the deepest interest to the antiquarian, but it is a distinct addition to the history of the literature of this country. He is not content with giving illustrations of almost every horn book that he has seen and reproductions of a number of well known pictures in which a horn book is to be seen, but has even packed away in the covers of his volumes facsimiles of horn books proper and of the card horn books that succeeded them.

To begin with, Mr. Tuer quotes several definitions of the horn book, but none is so clear as his own—albeit the passage is a little faulty in construction—given when he is describing the horn book.

"When papyrus was superseded by parchment and vellum—but in days far behind the invention of paper



THE BATEMAN HORN BOOK—FRONT.

and printing—the horn book was the happy thought of an overtaxed scribe, who, heartily detesting the profitless labor of rewriting the A B C, fastened the skin to a slab of wood and covered it with horn. For in those days, as in these, children were prone to destruction, and, without taking into account the innocent mischief resulting from damp and grubby paws, they doubtless turned their master's careful handiwork into boats, or sent it skyward, trailing behind their kites."

The earliest record that Mr. Tuer has found of a real horn book is 1450. At that time horn books were printed in black letter, but when Roman was introduced in 1467 the clearness of the latter soon drove its elder brother out of the field.

"The earliest horn books or tablets—in some the letters were incised on the wood, in others they were written—contained nothing but the alphabet. Devotional booklets for children, opening with the A B C, followed, and the alphabet horn book and the little A B C book of prayer ran side by side. Then the horn book itself assumed the devotional form it has since retained, the earliest examples (in Latin) ema-

THE BATEMAN HORN BOOK—BACK.

nating from the Romish Church. About the time of the Reformation we get the horn book—of which there were many varieties—in the English form."

Later on there were horn books for teaching writing which were distinct from those for teaching reading, and served the purpose now fulfilled by the headlines of copy books. Horn books finally went out of use about the beginning of this century. In this connection, and as showing how rare the horn books had become, there is an interesting remark by William Hone, several of whose notes have never before been printed, and are quoted by Mr. Tuer:

"A large wholesale dealer in stationery and school requisites recollects the last order he received for horn books came from the country about the year 1799. From that time the demand wholly ceased; twenty years afterward, in clearing out his warehouse, a gross or two were found and destroyed as useless. In the course of sixty years he and his predecessor in business had executed orders for several millions of horn books. What would that 'gross or two' be worth now?"

In the British Museum there are but three complete horn books, one of which is not genuine. In South Kensington there are eleven. The Bodleian Library can boast of three. The best talked of horn book is that until lately in the Bateman Museum, Youlgrave, Derbyshire. When the Bateman heirlooms were sold it fetched 65 l., its original cost having been one penny.

We are indebted to the London Graphic for the cut and particulars.

* "History of the Horn Book," by Andrew W. Tuer, F.S.A., illustrated, in two volumes. (The Leadenhall Press: Simpkin, Marshall, Hamilton, Kent & Company.)

PRACTICAL PHOTOGRAPHY WITH ROENTGEN RAYS.

By G. WATMOUGH WEBSTER.

IT is advisable to have all the wires carefully insulated. The Crookes tubes giving the best results are those of the focus type of truncated cone form.

The first thing to be done is to fix the Crookes tube in a steady position, which can be done by any extemporized holder, or by the aid of a laboratory tube holder. A certain amount of firmness is desirable, for, though it may be suspended from a loop at the end of one of the secondary wires, in which case the latter must be secured to a holder, and the loop be close to the support, it is most desirable to prevent any swinging. If the tube is not stationary, the rays are naturally emitted from a larger area, and such an object as a hand will, in consequence, have the bones represented less sharply, through the penumbra being wider.

The tube being fixed, and one end connected with one terminal wire, it only remains to attach the other terminal to the second electrode of the tube, and turn the commutator so as to allow the current to pass. Immediately the luminosity in the tube becomes visible the green glow of the cathode should be at the wide circular metallic disk. If it should not be so seen, the current should be reversed by giving the commutator a half turn, when the glow will be transferred to the disk, which is now the oft quoted "cathode," whence the rays have their original cause, though where they actually start from is still not decided. The cathode rays seem first to need to impinge upon some substance before the Roentgen rays are obtained. It is stated that Edison, by means of a long metal tube and a fluorescent screen, has tried to locate them, and found them to come from all parts of the vacuum tube.

It is necessary to give certain cautions to safeguard the tubes.

First it must be observed that the two loops of thin wire fused into the tube must be most carefully treated, or they will either be broken off short or the glass tube at the point be split or cracked, an event which would ruin the tube by the gradual inflow of air. I can speak feelingly on this point, for I had a magnificent collection of the old vacuum tubes, nearly a score in number, and I lent them to a scientific friend, whom I thought I could safely trust to handle them with care. When he returned them nearly every tube was ruined from either this cause or another which I will mention.

Secondly, if the tubes be not carefully and sufficiently attached to the secondary wires, it may happen that one wire will spring away, and if in springing the uncovered end of the wire should touch, be it ever so lightly, or approach at all closely the walls of the bulb, it is very probable that a spark may pass from it to the tube, and, if it does, the tube is irretrievably damaged, as the spark will pierce a microscopic hole which would let in the outer air. One of the Crookes tubes I have been experimenting with "gave out" in the middle of an exposure for no apparent reason. I can only imagine that a spark passed from the supporting wire to the glass, and thus pierced it.

The deduction from this recountal is obvious. The leading wires should only be uncovered for a very slight distance from the loop that attaches them to the tube; there will then be little danger of "sparking."

In attaching the wires to the tubes they will be found to behave in a most refractory manner, springing away and straining the tube electrodes when threading them. This is best avoided by using covered wires as thin as possible, not thicker than No. 24 gage, and they may be bent into a spiral by wrapping round a long pencil, which is then removed. A wire so shaped has less spring in it. It will avoid strain if the end of the wire have a loose link of covered wire, making a sort of chain.

There is nothing now to be done but to place the object to be photographed upon the sensitive plate. This should be placed not in a dark slide, but inside a bag of threefold black paper, and the object to be electro-sciographed put upon the paper. Now, though it is difficult to fix upon the exact point of area of radiation, it is certain that, the further removed the tube is from the object, the sharper the shadows will be, and, if the power of the tube sufficed, a distance of twelve or eighteen inches would enable the shadows to be beautifully clearly defined. This, however, is not a very practicable distance, for it has been estimated that the actinic action decreases about as the square of the distance, so for twelve inches the exposure needed would be sixteen times as great as at three inches.

In taking electro-sciographs of the hand or foot, the position of the tube must be regulated by what point is most likely to be needed in the sharpest definition. If the tube be suspended over the knuckles, the division between the bones will be clearly shown; if over the wrist, it is obvious the rays will pass across the separating space, and no line between the finger joints will be perceptible. The further the tube is removed, the less, of course, do these remarks apply.

Again, it will be found that some hands will not lie flat on a plane surface, the fingers will spring up and form a shallow arch. Clearly, the bones would not be so sharply defined. If it be a case where sharp definition is wished for, the hand should be bandaged flat to the plate. The rays will pass through the bandages and act on the plate as though they were absent.—British Journal of Photography.

THE GERMAN EMPEROR AND HIS FAMILY.

We present an engraving of William II and his sons taken from his latest photograph. For this picture we are indebted to the Graphic. William is one of the most versatile monarchs that ever sat on a throne, and the enthusiasm with which he takes up various sports and occupations is really refreshing, so that it is little wonder that he is nearly always in the public eye.

THE GERMAN EMPEROR, WILLIAM II, AND HIS SONS.

Frederick William Victor Albert, now known as William II, was born January 27, 1859, in Berlin, and until he was fourteen years old his education was intrusted to Dr. Hintzpeter, assisted by Major Von Gottberg, who was military instructor. At this time his corps of teachers was increased by the addition of Prediger Persius, who prepared him for his confirmation, which took place September 1, 1874, at Potsdam. As William was to lead an active life, it was thought best to send him to the gymnasium at Kassel.

Orders were given that he and his younger brother Henry, who accompanied him, should receive the same treatment as the other pupils, and this order was strictly obeyed. He graduated from this school January 24, 1877, just before his eighteenth birthday. After this his military career began with his entrance as an officer into the first Garderegiment at Potsdam, that he might become thoroughly acquainted with practical service. The young prince was assigned to the company which his father had once commanded. After serving here for a short time he went to the university at Bonn, and from there went back to the army again. Emperor William ascended the throne in June, 1888, upon the death of his father, Frederick III.

In 1880 he was betrothed to Augusta Victoria, Princess of Schleswig-Holstein, and on February 9, 1881, they were married. The Empress is about a year younger than the Emperor, and makes an excellent mother to her four little sons, to whom she is devoted. Their oldest child, little Prince William, the present Crown Prince, was born at Potsdam, May 6, 1882. His father's devotion to the army will doubtless prompt him to make a soldier of his son at an early age; in fact, he wore the uniform of a fusilier of the guard before he was six years old.

The Emperor has seven children. The eldest, the Crown Prince of Germany and Prussia, is Prince Friedrich-Wilhelm-Victor-August-Ernst, born May 6, 1882. The second child is Prince Wilhelm-Eitel-Friedrich-Christian-Karl, born July 7, 1883. The third is Prince Adalbert Ferdinand-Berenger-Victor, born July 14, 1884. Prince August-Wilhelm-Heinrich-Victor was born January 29, 1887. The fifth child, Prince Oscar-Karl-Gustav-Adolf, was born July 27, 1888. The sixth child is Prince Joachim-Francois-Humbert. He was born December 17, 1890. The youngest is a girl, Princess Victoria-Louise-Adelaide-Mathilde-Charlotte. She was born September 13, 1892.

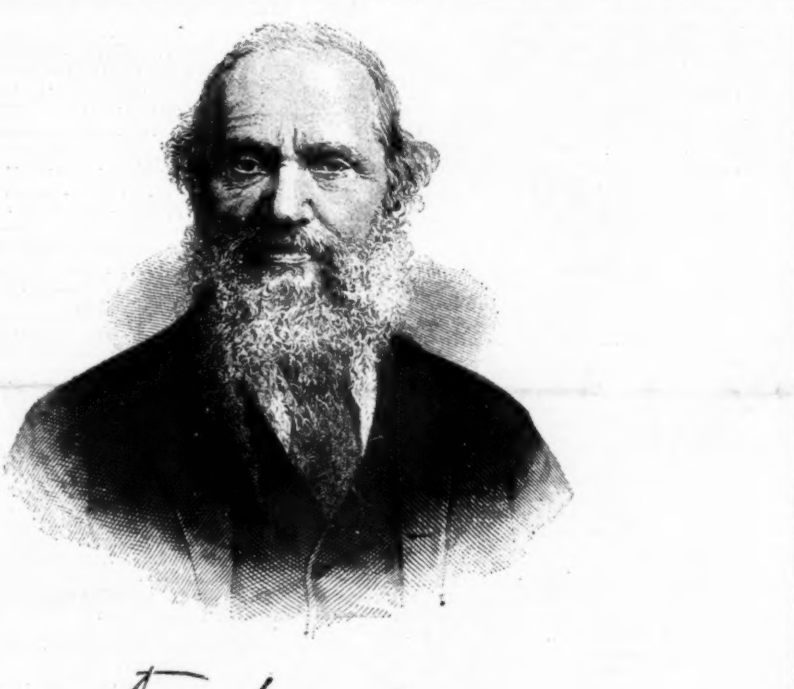
The principal events which have occurred in Germany since the present Emperor succeeded have been,

first, the rise of the anti-semitic movements, which resulted in the exposure of stupendous frauds; second, the system of uniform time, which was adopted March 31, 1893; thenceforth the mid-European time—that of the 15th degree of longitude east of Greenwich, obtains all over the country; the army bill; and lastly his trouble with Bismarck and his reconciliation to the "Iron Chancellor," which is still fresh in the memory of all. The Emperor is very fond of traveling, and considerable time each year has been spent in paying visits, catching whales, etc. In 1890 his Imperial Majesty paid a state visit to Heligoland; in 1891 to Amsterdam, and later in the year, accompanied by the Empress, he visited England, where he was feted and presented with the freedom of the City of London. In April, 1893, the Emperor attended the silver wedding of the King and Queen of Italy, and took this opportunity of visiting Pope Leo XIII. In July of the same year he won the Queen's Cup in the races at Cowes. The total income of the Emperor is about 15,719,000 marks, or $3,752,000.

LORD KELVIN'S JUBILEE.

THE celebration of Lord Kelvin's jubilee as professor of natural philosophy at Glasgow University began on June 15. Congratulatory telegrams were received from all parts of the world. A cable dispatch sent by Lord Kelvin thanking those who had congratulated him was sent around the world and returned to the university in four minutes. A number of delegates from foreign universities were present at the celebration. The programme of the celebration was as follows:

On Monday, June 15, at 8:30 P. M., there was held a conversazione, with an exhibit of Lord Kelvin's inventions. On Tuesday, June 16, addresses were presented to Lord Kelvin by delegates from home and foreign university bodies, from societies, and others. On Tuesday evening, June 16, a banquet was given



Yours truly
William Thomson

in honor of Lord Kelvin. On Wednesday, June 17, the senate of the Glasgow University invited the visitors of the university staff to sail down the Clyde. The students of the university also invited the students' delegates from other universities to a similar trip.

William Thomson, Lord Kelvin, president of the Royal Society, was born in Belfast in June, 1824. His father was appointed professor of mathematics in the University of Glasgow. When the son was only eleven years old he entered the college, and shortly after completing his course he removed to Peterhouse, Cambridge, where he was graduated in 1845 as second wrangler, being immediately afterward elected to a fellowship.

In 1846 he was appointed professor of natural philosophy in the University of Glasgow, which post he has occupied continuously for fifty years. In the same year he accepted the editorship of the Cambridge and Dublin Mathematical Journal, and to this magazine he contributed valuable additions to the mathematical theory of electricity. Among the most important of his contributions to the advancement of electrical science are the construction of several beautiful instruments and their application to the study of atmospheric electricity.

But it is in connection with submarine telegraphy that Lord Kelvin's letters in electrical science are best known, he being the inventor of the mirror galvanometer and the siphon recorder, which, owing to their extreme delicacy, can be worked by very low battery power, a circumstance that tends greatly to the preservation of the cables. To the science of magnetism Lord Kelvin has made important additions. In the investigation of the nature of heat, his extraordinary power of mathematical insight is seen to great advantage.

On the successful completion of the Atlantic cable, in 1866, he received the honor of knighthood, and was presented with the freedom of the city of Glasgow. The degree of LL.D. was conferred on him successively by the universities of Dublin, Cambridge and Edinburgh, and that of D.C.L. by Oxford. He is a fellow of both the London and Edinburgh Royal Societies, from the former of which he received the royal medal and from the latter the Keith prize. He delivered the Rede lecture at Cambridge in 1866; was president of the British Association at its meeting in Edinburgh in 1871, and was elected president of the Geological Society of Glasgow for the year 1872. On October 29, 1872, he was elected a fellow of St. Peter's College, Cambridge. He has also received various decorations from abroad. He is grand officer of the Legion of Honor, commander of the Order of Leopold, and has received the German Ordre pour le Merite. In December, 1877, he was elected by the Paris Academy of Sciences foreign associate.

He has been president of the mathematical and physical section of the British Association five times. He is the inventor of a very extensively used improved form of the mariner's compass, in which complete and perfect correction against disturbance by the ship's magnetism, temporary and permanent, is provided, and of a sounding machine, by means of which soundings are taken in depths up to 100 fathoms without even slackening the speed of the ship. He has also of late years devoted much attention to the subject of electric lighting, and is the inventor of a great variety of instruments designed for measuring the electric currents and potentials used in that industry. He was created first Lord Kelvin in 1892.

[Continued from SUPPLEMENT, No. 1068, page 17072.]

WHAT IS BITUMEN?*

By S. F. PECKHAM.

THE word petroleum, signifying rock oil, from its derivation, is properly applied to oily rather than viscous fluids. The viscous forms of bitumen, passing by insensible degrees into semi-solid or solid forms, have been designated by some French writers as "bitume glutineux," and by others as maltha. In the United States some writers describe all forms of bitumen, betwen natural gas and asphaltum, as petroleum, sometimes qualifying given specimens as "very light," "very heavy," "viscid," etc. This obscurity first arose in Europe, from a lack of detailed knowledge concerning the chemical constitution of fluid bitumens. De Saussure analyzed the "Naphtha of Amiano," in 1817,† as if it were a homogeneous substance, and Boussingault, in 1837,‡ prepared his celebrated memoir upon the "Composition of Bitumens," apparently with the idea that he had separated the maltha of Bechelbronn into petroleum and asphaltum, each of which were analyzed as if they also were homogeneous substances. In the United States, prior to the discovery of the Trenton limestone oils, it was assumed that there was no essential difference in petroleums, except in the proportions of the several ingredients mixed together in the oil.

True, Warren and Storer had shown, in 1865,§ the essential unlikeness of Rangoon and Pennsylvania petroleum, and later I myself showed the large amount of nitrogen in California oils; but Prof. J. D. Dana‖ apparently preferred to consider petroleums as rocks rather than species, and in his "System of Mineralogy," inserted Warren's series of paraffines and isoparaffines as species, although at the same he made species of albertite and grahamite, etc., which we now have a right to believe, I think, only differ from liquid petroleums in the members of the paraffine and other series of hydrocarbons which they contain. Quite lately, Maybery* has shown that the Trenton limestone oils contain compounds of sulphur; and Salathe and myself have discovered the esters of the pyridin and other benzole bases in California petroleums,† and there are very good reasons for concluding that they are constituents of all the tertiary petroleums of the Pacific coast of both North and South America. It has been further shown that the Russian petroleums consist of hydrobenzoles,‡ while there are many reasons for believing that there are several other groups yet to be determined among European liquid bitumens. In the United States, also, there is clearly to be distinguished from all others yet investigated a group found in the great interior valleys of the eastern slope of the Rocky Mountains, extending from Texas north into British America and the valley of the Mackenzie River.

Some of these fluid varieties of bitumen, both in Europe and America, pass, by insensible degrees and through natural causes, into maltha, which is a semi-fluid, viscous form of bitumen, known as mineral tar, and just as clearly to be distinguished in consistence from petroleum as common tar is to be distinguished from olive oil. I have found the change by which California petroleum is converted into maltha to be due to two causes, viz., evaporation and indirect oxidation.§ By this latter term, I mean, not that oxygen becomes to any extent a component of the maltha, if at all, but that by oxidation and removal of hydrogen the molecules are condensed as the proportion of carbon increases. Prof. Henry Wurtz would have us believe that this change is due to polymerization.‖ I cannot interpret the result of my experiments as indicating such a result alone. When air, ozone, or chlorine is passed through the paraffine petroleums, they are condensed by evaporation to a residue resembling vaseline. When California petroleums are treated in the same manner, they are condensed by decomposition into, first, maltha, and then asphaltum. Chlorine will effect this change just as readily as ozone.¶ Destructive distillation will also effect the same or a similar change, the residue being either an asphaltic residuum or coke, and the distillate a hydrocarbon richer in hydrogen than the original bitumen. The natural malthas contain both water and air in mechanical admixture.

When the solid forms of bitumen are reached, the want of clear distinctions becomes still more pronounced. The work of M. Jaccard affords an illustration of the lack of clear ideas expressed in clear language in which some authors indulge. The late Dr. T. Sterry Hunt, as long ago as 1863,** separated pyrobituminous from bituminous minerals. This important consideration, while not wholly disregarded by M. Jaccard and other authors, does not appear to be fully appreciated by him. The fundamental principle underlying the use of this word exists in the fact that "pyrobituminous" coals, schists and shales yield, on being heated to destructive distillation, products that resemble bitumens. Why this clearly scientific, wholly reasonable and very convenient basis of classification has not been made the foundation upon which all scientific discussions relating to bitumens proceed, whether from the point of view of geology or any other point of view, it is difficult to explain. Yet, until this distinction is fully recognized, writers will continue to mix up bituminous coals, schists of Autun and Mansfeld, boghead mineral, etc., with all sorts of bitumens, as M. Jaccard has done, to the infinite confusion of the discussion of bitumens. These coals, schists and shales are nearly as insoluble in the solvents of bitumen, viz., ethyl ether, chloroform, benzole, etc., as they are in distilled water; hence, Dr. Hunt made the action of these solvents exclusive of the two classes of substances. All true bitumens are miscible with, or almost wholly soluble in, chloroform, a test that clearly separates them from pyrobituminous minerals. So-called "asphaltic coals" are not coals at all, but are simply geologically old asphaltums.

In whatever manner bitumens may be classified, it is apparent from the outset that there are a large number of minerals, consisting in part of true bitumens, that are, strictly speaking, rocks. To this class of substances belong the bituminous sandstones and limestones of the upper valley of the Rhone, the Limmer and Ragusa rocks, the Niagara limestone of Chicago, the bituminous limestones of Utah, the Turrelite of Texas, the sandstones of Kentucky, the Indian Territory, and the Athabasca River and California. These are found as beds of sedimentary or crystalline rock, often of immense extent and thickness, impregnated with bitumen of varying consistency and quality, sometimes nearly fluid, but never solid, after being separated from the rock. In some instances the bitumen appears to be convertible into asphaltum, and in others not. The French writers have called these rocks "asphalte," but unfortunately they have also called asphaltum by the same name, as if the things were identical and the words synonymous. Among English writers no uniform custom prevails, but German authors use generally the French word. I think it would promote clearness of expression if this word "asphalte" were uniformly introduced into all modern languages to designate these bituminous rocks, with the qualifying words siliceous, calcareous, or argillaceous added as required.††

* Read before the Chemical Section of the Franklin Institute, October, 15, 1895.

† Annales de Chim. et de Phys. (2) 4, 314-330.

‡ Ibid. (2) 64, 141. Jour. Frank. Inst., 24, 138.

§ Mem. Am. Acad., N. S., 9.

‖ Dana's Mineralogy, 5th edition, 1869. I am aware that in the edition of 1892 the arrangement more nearly approaches that suggested in this paper.

* Jour. Frank. Inst., 139, 401.

† Am. Jour. Sci., (3) 48, 250.

‡ Beilstein u. Kurbatow, Ber. d. Deut. Chem. Ges., 13, 1818; Schutzenberger et Jonine. Bul. Soc. Chim., Paris, 1880, p. 678. Since the above was written, a memoir by Wanklyn and Cooper has appeared in the Chem. News, 72, 7, in which it is shown that a new group, called by them "keroses," exists in Russian kerosene.

§ Am. Jour. Sci., (3) 48, 254.

‖ Engineering and Mining Journal, 1889, 1890, 1891.

¶ Proc. Am. Philos. Soc., 10, 445.

** Am. Jour. Sci., (2) 35, 157. Chemical and Geological Essays. J. R. Osgood & Co., Boston, 1875

†† Last December, Miss Laura A. Linton published a paper in the Journal of the American Chemical Society, upon the "Technical Analysis of Asphaltum." In this paper the words asphalt and asphaltum were used interchangeably. The paper was reprinted in the London Chemical News, and the careful editor added the letter e to asphalt wherever it occurred. I have looked through all of the English and American dictionaries, from Samuel Johnson's down, and through all of the cyclopedias printed in English, to which I have access, including the ninth edition of the Britannica, and I cannot find the word asphalte anywhere as an equivalent for asphalt. Asphalte is not an English word.

The so-called Trinidad pitch, as it is found in and around the lake, is a unique mixture of bitumen, water, mineral and vegetable matter, the latter usually determined as "organic matter, not bitumen," and the whole inflated with gas. When removed from the deposit the water rapidly dries out, the gas escapes, the mass becomes brittle and changes from a brown to a blue black color, acquiring a sticky consistency as it loses water. At a rough estimate, less than 25 per cent. of the mass of the natural cheese pitch is bitumen; it is, therefore, quite improperly called the largest deposit of bitumen in the world. I think that the Trinidad pitch, so called, is properly to be considered a mineral species, and I suggest for it the name "parianite," in reference to the formation in which the celebrated lake occurs.

The words natural gas, naphtha, petroleum maltha, asphaltum and asphalte are not names of things, but words which indicate accidents of occurrence, to which any species of bitumen may be subject. When a true system of classification of the species and sub-species under bitumen has been reached, it will be found that a species may occur in nature in any or all of the several conditions, from natural gas to asphalte. A true system, therefore, must name and classify the bitumens themselves. As an illustration of my meaning, I would suggest that the constitution of Pennsylvania petroleum, having been first shown by C. M. Warren to consist in a mixture of paraffines, isoparaffines, etc., this species of bitumen embracing the natural gas and petroleum of western Pennsylvania, eastern Ohio and West Virginia, may properly be named "warrenite." As Prof. C. F. Maybery has first clearly pointed out the characteristics of the Trenton limestone oils by means of his researches upon the sulphur compounds contained in them, I would suggest for this species of bitumen the name "mayberyite." As the California bitumens containing the esters of pyridin, etc., are largely found in Ventura County, I would suggest for them the name "venturaite."

I am aware that these suggestions are based upon data very inadequate for the purpose of complete classification, yet I contend it is a classification that will classify things and not names, and, in time, may be made sufficiently complete for the purposes of mineralogy as well as technology.

The old terms will still have their places and uses by which to indicate the physical conditions under which these different mineral species are found. As an illustration, I will suggest that a description of "warrenite" would include the statement that it is found as natural gas, naphtha, petroleum, etc.; that it consists of paraffines, isoparaffines, olefines, a trace of benzoles, etc. Analyses might be given from the researches of Warren and Storer, Pelouze and Cahours, Ashburner, etc. It occurs along the western slope of the Allegheny Mountains, from New York to southern Kentucky, in natural springs and artesian borings.

"Mayberite" is found as natural gas, petroleum and maltha; it consists of paraffines (?), isoparaffines (?), olefines (?), esters of the pyridin bases (?), and Maybery sulphur compounds. Give analytical references. It occurs in the petroleum region of Canada, in northwestern Ohio and Indiana, and southward.*

"Venturaite" is found as natural gas, petroleum, maltha and asphaltum; consists of hydrobenzoles (?) esters of pyridin bases, etc. It occurs throughout Southern California, as petroleum in artesian borings; as maltha saturating sand at Las Conchas, in enormous springs on the Ojai, and in many other localities; as asphaltum, in veins of immense extent, probably the largest in the world, at Asphalto, Kern County, Cal.; also at La Patera, Santa Barbara County, in the same State.

It goes without saying that there has been no scientific examination of any solid bitumen that is worth mentioning; consequently, any attempts at specific description like those given above are like a skimmer, consisting chiefly of vacant spaces. Nevertheless, shall we go on multiplying words about the "bitumen of the Dead Sea," "Trinidad pitch," "California asphalt," etc., or shall we begin to learn by first discovering how difficult it is to answer the question: "What is bitumen?" Let those who think they can answer it first read M. Jaccard's book.

University of Michigan, Ann Arbor, Mich., August 24, 1895.

—The Journal of the Franklin Institute.

MEMORY AND ITS LOSS.

Two recent cases have directed popular attention to one of the most mysterious results of altered cerebral function—an absolute loss of that which is called "memory." The symptom is so striking, so conspicuous, and so simple, that it is natural for it to attract attention, and natural, also, that it should seem to be, in some way, susceptible of explanation. But, in truth, it is one of the derangements which bring into prominence the cerebral function of which we know perhaps less than we do of any other. There are two elements of the process which is included in the term "memory." They are generally confused, although one is often distinguished as "recollection." That which we call "recollection" is the voluntary use of memory; and it is the power of the will over memory, and not memory itself, which is lost in such cases as those which have recently attracted attention, and of which instances are familiar enough in medical science.

The physical basis of memory rests on the fact that every functional state of the brain leaves behind it a residual condition, in consequence of which that precise condition, in the same degree and the same combination, is more readily reproduced. The tendency for the state to occur again is the greater the more frequently it has previously occurred. It is this law which of course underlies all physical education, as well as all memory, commonly so termed. The occurrence of special nerve processes in association with each other leaves behind a tendency for the recurrence of the association, so that one "idea" causes the revival of another. The physiologist and the physician are mainly concerned only with the physical processes in the brain which correspond to and accompany the mental processes, with which they, as physicians or "physical physiologists," have less to do. But with these is combined the influence of revival of past activity, which is itself subject to the determining power which we call the "will." This association has baffled, and must apparently for ever baffle, our scrutiny. It is far beyond the range through which science can penetrate. We know of its workings by subjective facts on the one hand, and on the other by its effects. Among these effects is the susceptibility of the renewal of past brain processes to the will. We can voluntarily recall the impressions of the past, we can induce the same combinations of nerve action, but how we know not. True failure of "memory" can only be assumed in the cases in which there is a general depreciation of the cerebral functions. In consequence of impaired nutrition of the brain, the functional states do not leave the due residual effect which facilitates their revival. The change may be compared to the difference in the depth and in the permanence of the furrow in soils of different cohesion when the plowshare cuts into them. On sand, for instance, as a much quoted phrase reminds us, the plowshare, instead of leaving a permanent furrow along which it can, if necessary, easily glide again, makes only a slight depression, almost at once filled up by the non-coherent particles from the crests. Such failure of memory is seen in old age, in general degenerations of the brain tissue, and also, in a striking way, in some cases of cerebral anæmia. In profound deficiency of the blood, qualitative or quantitative, the state of the brain may be such that no mental impression leaves an enduring trace such as can permit its reproduction. In such conditions there is a true failure of memory. But we cannot assume that this is the case when there is only a simple loss of the power to revive past impressions by the will, such as occurs as the result of sudden local disease or sudden injury. A severe concussion may be followed by a period during which there is unconsciousness and afterward by a return of an apparently normal mental state. Everything up to the moment of the accident may be recollected, but everything afterward may be an absolute blank. Even if the sufferer soon regains consciousness and appears to be in normal mental vigor, the residual states left by his mental processes are not within the power of will to recall. Such sudden change, probably in some cases at least a sudden local lesion, limits the power of the will in a curious way. The will can induce the revival only of those processes which occurred a long time previous to the alteration. It is a well known fact that the earlier in life cerebral processes occur, the more easily are they revived. After middle life the difference in the intensity of the residual states, or perhaps some difference in their relation to the mysterious influence of the will, makes them so much less amenable that such a sudden alteration as may be caused by a local lesion will withdraw them from the influence of volition. This can scarcely be spoken of as true loss of memory: it is loss of voluntary recollection, and that is all we can say.

Strange, indeed, is the apparent slightness of the cerebral influence which like a gearing apparatus keeps within the power of the will these residual states. Who does not know how a vivid dream may be recalled by some chance incident, revealing that an apparently dreamless night was filled with activity? In the curious brain state which follows a slight epileptic fit, in the state of "automatism," as it is termed, residual states must be produced as definite and as deep as any which occur in normal conditions, but they are beyond the power of the will and of any association to reproduce them. In a case recorded by Dr. Gowers a carman drove his van across London, steering his way with precision through the crowded streets, and then suddenly found himself six miles distant from his destination. During the hour which had elapsed innumerable incidents must have left impressions deep enough to have enabled them to be reproduced at once by a voluntary effort, were it not for the sudden breaks in the continuity of consciousness which occurred—first, when he, as the saying is, "lost himself," and secondly, when he "came to himself." Rarely, in some like state at a subsequent period, the connection with the past may be re-established. As a rule, in this morbid state, the missing link in the mechanism of voluntary recollection is never re-established. But it is otherwise when there is a sudden loss of the power of the will over the residual states produced under normal conditions, but which have been separated from volition by some sudden change. In such cases as those which have been discussed so much of late in the daily press, the residual states are there, and, at some link in the chain of association which exists between them, a renewal of the lost influence may occur, and may then quickly spread through the whole series; the memory may suddenly give signs, quickly increasing, of returning susceptibility to the will, which we call the power of recollection—a word which seems so simple, and yet denotes the greatest mystery of brain and mind.—The Lancet.

* In one instance, I obtained a qualitative reaction for the pyridin bases in a sample of commercial "lima tar." I have not yet been able to verify their presence in other and authentic samples.

Vinegar as an Antidote to Carbolic Acid.—Prof. Carleton, of New York, states that vinegar is an excellent antidote to phenol. When applied to a cutaneous or mucous surface which has been burned by the acid, the characteristic whitish appearance produced by the caustic at once disappears, and subsequent scarring is to a large extent prevented. Vinegar is also said to be equally good as an antidote when the acid has been taken into the stomach, and it is recommended that the patient should, as soon as possible, drink some vinegar mixed with an equal part of water, after which other measures may be taken to more fully counteract the poison.—Lancet.

To Harden Steel in Petroleum.—According to B. Morgossy, the articles to be hardened are first heated in a charcoal fire, and, after thoroughly rubbing with ordinary washing soap, heated to a cherry red. In this condition they are quickly plunged into petroleum; ignition of the petroleum need not be feared, but, of course, an open flame must not be near at hand. Articles hardened according to this method show no cracks, do not warp in the least, and after hardening remain nearly white, so that they can be blued without previous rubbing with emery.

SELECTED FORMULÆ.

Cockroach Powder.—

	Parts.
Powdered angelica root	100
Oil of eucalyptus	20

Mix. Scatter around where the roaches go.—National Druggist.

Glue for Use in Forming Paper Tablets or Pads.—

	Parts.
Best glue	64
Glycerine	32
Linseed oil	8
Sugar	4
Water	q. s.

Soften the glue by soaking in a little cold water, mix with the other ingredients, and dissolve by heating on a water bath.

Moth Killers.—Most of the moth killers of the present day contain naphthalin (so-called "coal tar camphor") as their active ingredient, alone, or in combination with gum camphor or other insecticides. We append a few formulas:

Cedar Tar Camphor—

	Parts.
Powdered naphthalin	19
Oil cedar	1

Moth Powder—

		Parts.
(1)	Naphthalin	2
	Camphor	4
	Oil cinnamon	2
	Oil eucalyptus	2
	Patchouli	10
	Valerian	5
	Tobacco	2
	Orris root	5
	Sumbul root	5

All the ingredients to be powdered.

(2)	Naphthalin	3,000
	Camphor	1,000
	Cumarin	2
	Nitrobenzine	10
	Oil neroli	1
(3)	Capsicum	1
	Naphthalin	4
	Insect powder	5
(4)	Cloves	50
	Black pepper	100
	Quassia	100

Sprinkle the powdered drugs with

Oil cassia	2
Oil bergamot	2

Previously dissolved in

Ether	20

Then mix with

Ammonium carbonate	20
Orris root	20

Moth Essence—

		Parts.
(1)	Naphthalin	10
	Carbolic acid	10
	Camphor	5
	Alcohol	500
	Spirit lemon	5
	Oil thyme	2
	Oil lavender	2
	Oil savine	2

This may be used by sprinkling, or, better still, by means of an atomizer.

		Parts.
(2)	Oil patchouli	1
	Nitrobenzine	9
	Naphthalin	20
	Carbolic acid	20
	Camphor	50
	Oil turpentine	50
	Alcohol	850

Mix, let stand for several days, and filter.—Merck's Report.

Liquid Glues.—

		Parts.
(1)	Gelatin (clear)	100
	Glue (cabinetmakers')	100
	Alcohol	25
	Alum	2
	Acetic acid (20 per cent.)	200

Heat on a water bath for six hours.

(2)	White glue (best)	4
	Lead carbonate	1
	Rain water	8
	Alcohol	1

Dissolve the glue in the water on a water bath, stirring constantly; then mix in the lead carbonate, add the alcohol, and continue the heat for a few minutes; lastly, pour into bottles while it is still hot.

		Parts.
(3)	Glue	12
	Water	32

Let stand for several hours, then add:

Hydrochloric acid	2
Zinc sulphate	3

Heat the mixture to 185° F. for ten or twelve hours.

(4) Crush 100 parts of brightest gelatin as minutely as possible, and pour water over it until it is entirely covered. Allow to swell for twenty-four hours, adding more water as the upper layer of glue dries out. Now rub up 10 parts of zinc oxide with water in a porcelain mortar to a liquid paste, and add 11 parts of concentrated hydrochloric acid; the zinc oxide will quickly dissolve. When gas ceases to be evolved, filter, and add the clear zinc solution to the glue, stirring the mixture thoroughly while pouring it in. Liquefy the glue at a heat of about 140° F. (but not over an open fire), and add 1 part of alum previously dissolved in the minimum quantity of water. Now let the whole stand (at the same temperature) until all the impurities rise to the surface, when the transparent glue underneath is carefully decanted and admixed with 2 parts of alcohol.—Merck's Report.

ENGINEERING NOTES.

Steel wool has been introduced as a substitute for glass paper in Germany. It is made of threads of shredded steel with sharp cutting edges, works more quickly and uniformly than sandpaper, does not gum or clog, and, being flexible, can be used in smoothing elaborate carvings.

An important engineering work of freeing the Venetian lagoon, near Chioggia, from inundation and the consequent malaria has been completed. A canal ten miles long and costing $1,600,000 has been built, carrying the waters of the Brenta and the Bacchiglione across the lagoon direct to the Adriatic.

At a recent meeting of the Société Industrielle du Nord de la France, M. Neu stated that trials recently made of a 100 horse power Laval turbine at the Bordeaux Exhibition showed a consumption of 19·3 lb. of steam per effective horse power hour when fully loaded, and of 23 lb. at half load. A 300 horse power turbine took 16·5 lb. of steam per effective horse power hour.

The deepest mine shaft in the world is said to be the Red Jacket shaft of the famous Calumet and Hecla mine, which has now reached a depth of 4,900 ft. Its cross section measures 14 ft. by 22 ft. 6 in., and it is divided into six compartments. It was commenced in 1880 as a safeguard against stoppage of the mine by fires, which had broken out on the inclines on several occasions between 1884 and 1888. By its means an additional mode of access is given to the lower levels.

According to a return of the cost of power in the Antwerp Exhibition of 1894, by gas, oil, and steam engines, it was the same for gas and for steam for engines of 50 horse power, namely, 0·49d. per indicated horse power, producer gas being used. For 10 horse power it was also the same, namely, 1·06d. per indicated horse power, but for 2 horse power it was 2·93d. for gas, 1·74d. for oil, and 2·91d. for steam. The small steam engines were thus very expensive steam pipe obstructions.

The Railway Age prints the following list in order of the sixteen leading systems of this country, with the mileage, as follows: 1, Pennsylvania system, 8,882; 2, Chicago and Northwestern, 7,931; 3, Atchison, 7,555; 4, Burlington, 7,304; 5, Canadian Pacific, 7 103; 6, Southern Pacific, 6,717; 7, St. Paul, 6,169; 8, Missouri Pacific, 5,326; 9, Southern Railway, 4,644; 10, Union Pacific, 4,459; 11, Northern Pacific, 4,362; 12, Illinois Central, 4,332; 13, Great Northern, 4,256; 14, Rock Island, 3,573; 15, Grand Trunk, 3,512; 16, Louisville and Nashville, 3,163.

When the Transsiberian railway is completed, in 1900, it will be possible, says the Mining and Scientific Press, for a traveler to encircle the globe in thirty days. Over the new route the traveler can be in St. Petersburg 45 hours after leaving London, and 250 hours will see him in Port Arthur. A Russo-American steamship company, now in the course of formation, will land him in San Francisco seven days later, whence he can proceed via New York to London in about ten days more. The price of the round trip ticket need not be over $400 and might be as little as $250.

From Tscheljabinsk, a distance of about 1,280 miles of the railway is now being used for traffic, and the favorable effect upon industry and commerce is already perceptible. The towns along the line increase in size and number of inhabitants, and the imports already comprise articles which were previously unknown. In the principal streets of Tomsk electric light has been or is just about to be adopted, and the journey from Moscow to Tomsk can now be compassed in eight days. The railway department has hired a large number of workmen in Finland, who will be employed at the works on the Siberian Railway.—Engineering.

The survey of the volcano Popocatepetl, Mexico, for the purpose of determining the best location for an aerial cable railway to the summit, has just been completed, says the Engineering and Mining Journal. It has been determined to start the line from the ranch of Tlamacus, and it will be connected with the Interoceanic Railroad at the base, so that the business of shipping sulphur can be cheaply accomplished. This new railway will be a great attraction to tourists, who will now be able to make the ascent to the summit, 18,000 ft. above the sea, and also descend to the crater, where the process of extracting sulphur is being carried out.

Dr. Hopkins, of the Agricultural Experiment Station at Morgantown, W. Va., who has given the subject much study, says there is great danger of the early destruction of the Ohio as a navigable highway, and along with it the Potomac, James, and Tennessee Rivers. To save these rivers, representing 2,000 miles in the aggregate, it is necessary to save the forests in a small part of Pennsylvania and Maryland and a considerable part of West Virginia and Virginia. From the estimates given by Dr. Hopkins, it appears that an area of about 1,000,000 acres should be reserved if we hope to save to posterity these immensely valuable highways of commerce.

It is pointed out by Dr. Coleman Sellers that one of the most notable examples of ball bearings, now growing in vogue, is the diminishing of the friction of the collar sustaining the hooks of a large crane. Thus, by making the crane hooks with flat washers, between which numerous small balls are placed, resting upon hardened surfaces, there seems to be no difference between the friction of rest and the friction of motion, and hooks heavily loaded are turned with remarkable ease; in fact, the use of balls distributed over plane surfaces is becoming a settled practice, there being no basket or grooves to separate the balls, as the latter are allowed to move at their own tendency, that is, in whatever may be their inclination. As to the size of the balls adapted to different purposes, various experiments show interesting results. In the case of hooks for cranes carrying about 50 tons, between 250 and 300 balls, each of ⅝ in. diameter, are scattered between the flat plates, on the assumption that the more points of contact the more lasting the balls; but some tests made with balls of different sizes, and motion kept up under loads to determine their durability, favor larger balls and fewer of them.—Chattanooga Tradesman.

ELECTRICAL NOTES.

At the Casino in Central Park, New York City, a very pretty effect has been obtained by bordering the outlines of the flower beds with a fringe of electric lights of different colors.

Electric light wire men frequently carry a small compass in their pockets, and before they touch a wire hold the compass near it. If the needle is not deflected, they know there is no current in it, and that it is safe to handle; but if the needle is deflected, they use the utmost caution lest they receive a severe shock and be perhaps killed.—N. W. Perry.

The Novosti states that the Russian naval authorities have decided to substitute a telephone invented by Lieut. Kolbasyeff for the speaking tubes now used on two of the battleships and one of the cruisers. These vessels are also to be fitted with the electric alarm bells invented by Capt. Vassilyeff for indicating where the ship has been hulled by shot.

A German paper says that five years ago it was considered very satisfactory if five hundred to eight hundred incandescent lamps were made per day with one hundred horse power; but to-day, says the Electrical World, it is possible with ten horse power and fifty workmen to manufacture over two thousand incandescent lamps per day and pack them for shipment.

It is said that in Spain electric fishing is to be carried on on a large scale. A Spanish company has taken out patents in Spain covering the use of the electric light for this purpose. The same scheme has been tried with some success in California, where a net was fitted with electric lights. It proved very attractive to the fish, which had previously been rather wary of entering the nets.

A curious case of trolley car which was struck by lightning comes from New Brunswick, N. J. The lightning ran down the trolley pole and entered the car. A part of it went through the lighting circuit, burning out the incandescent globes. The heat was so intense that the glass globes melted; some of the glass fell to the floor. This curious accident seems to make it necessary for some invention to be devised for the prevention of similar occurrences.

A new battery cell is described in L'Electricien. The leading feature of this new cell is the short distance between the plates. It is a carbon-zinc combination. The carbon is channeled down one side and filled in with a paste made of powdered carbon and manganese dioxide. The zinc plate is amalgamated in the ordinary manner, and is separated from the carbon by a thin piece of coarse felt. The liquid is a solution of two parts, by weight, of ammonium chloride to one part each of sodium chloride and zinc chloride. It is said that a cell 6½ inches high will give four amperes at a pressure of 1·5 volts.

From the proceedings of the Imperial Russian Association of Industries, says the English Electric Engineer it would appear that Mr. W. A. Tjurin has been repeating with success the French experiments on the attenuation of toxines by means of alternating currents. He states that under the influence of the current the virulence of diphtheria toxine can be so reduced that guinea pigs inoculated with it show hardly any symptoms of its action, while if, instead, the untreated toxine is injected they die in a day. The attenuated toxine acts as a prophylactic and the animals inoculated with it cannot afterward be made to contract the disease.

The well known firm of A. F. Smulders, of Slikörveer, Rotterdam, have made encouraging experiments with an electric dredging plant. The plant has, according to the Schweizerische Bauzeitung, been ordered by Mr. Bunau-Varilla, formerly engaged on the Panama Canal, for the Elsa River, in Spain. The electric machinery was supplied by Messrs. Brown, Boveri & Company, of Baden. The power is produced on shore, where a 150 horse power engine is driving a three phase generator whose currents of 2,000 volts are sent over to the dredger by a cable. On board the currents are converted down to 200 volts to drive the various electric motors. The obvious advantage of the arrangement is that the power plant on board becomes much simpler, that less men are required, and that the chaining of the dredger becomes easier than when a pipe connection has to be maintained between the dredger and shore. Whether the electric motor is fitted for the exceedingly rough work is a different question, which would, however, only be a temporary bar. Electric centrifugal apparatus have for some time been working on the Continent, says the Trade Journal Review; they had to be specially constructed, but they perform their duty. In this case five 10 horse power motors, three 25 horse power and one 15 horse power three phase motors are applied.

A series of articles on the question of the influence of temperature and electrification on the insulating power of gutta percha is completed in the Elektrotechnische Zeitschrift of February 6. The investigation was undertaken by Mr. H. Zielinski, in order to determine why the resistance of the older cables remained pretty steady throughout the year, while some newer cables showed a greater resistance in summer than in winter. The experiments were begun in 1893 and continued during the year 1894. The subject has more than a scientific interest, inasmuch as the final results prove that we may assume an average temperature coefficient for different sorts of gutta percha, because the probable errors in taking measurements would balance any deviations from the normal. Mr. Zielinski experimented with specially prepared cables, about one mile long; one of his cables had a length of almost three miles. These he heated in special thermostats, determining the resistances both during the rise and the fall of temperature. It may not be superfluous to mention in this place that the Germans call a thermostat a case in which a constant temperature can be maintained, while the English-American definition of the term is an apparatus by means of which the temperature is kept constant. The dampness of the ground has something to do with the variations in the resistance; if moisture does not affect a well-insulated cable, it often affects the auxiliary instruments.—Trade Journal Review.

MISCELLANEOUS NOTES.

A copy of the gospels written on purple vellum, in silver, was recently found in Asia Minor. It dates back to the sixth century. The precious manuscript has been secured by Russia.

Prof. Matericht, the Paris meteorologist, calculates that a hot, bright day in midsummer sees not less than 5,280,000,000 tons of water evaporated from the surface of the Mediterranean Sea.

Russian hens are progressive. They laid 11,000,000 eggs for export in 1870, 235,000,000 in 1885, and 1,250,000,000 last year. The eggs are sold in Russia at from six to ten cents a dozen. They are exported to Hungary, then sold to Germany as Hungarian eggs, and finally to England as German eggs.

Wire bolting cloth is a new article, of German origin, which promises to come into general use among our millers; indeed, many of them are already using it on sharp middlings, where it is said to do excellent work. Whether it can well be employed on flour stock is a question which remains to be answered.

The official statistics of the production of salt in the United States during the calendar year 1895 have been compiled by Statistician E. W. Parker, of the United States Geological Survey. The report shows the total production was 13,666,649 barrels of 280 pounds each. The valuation of the product is $4,423,086. These figures show an increase of 600,000 barrels in product over the previous year, but a decline of $300,000 in value. The largest production was in New York, with 6,795,616 barrels, an amount double that of Michigan, which comes next in quantity.

A new disease has developed among street car conductors. It is said that on a particular street car line the conductors frequently reported a swelling of the eyes, accompanied by partial blindness. One of the men, who had to undergo medical treatment, recalled the fact that from time to time his hands grew black from contact with the brass railing of the car when he jumped on and off. In windy weather he had to wipe his eyes more or less to brush away the moisture. He came to the conclusion that the contact with the rail was the trouble. He was treated for metallic poisoning and recovered without difficulty. He has since worn gloves and has had no recurrence of the ailment.

The underground bakeshops of New York City were recently investigated by Edward Thimme, who says they exhibit the most unsanitary conditions he has found in factories of any kind. There are, he says, 2,000 bakeries occupying cellars not intended for the purpose. These cellars are less than eight feet high. Ventilation is considered by the owner an expense and luxury. Air and daylight come in through a door in the front and one in the rear. Floors are in bad condition. Chickens are often found, and swarms of vermin are not an unusual sight. The atmosphere is unhealthy, for hundreds of men sleep on the flour, and the hours are long. Bakers are old men at forty. The bread they make is in many cases wholly unfit for food. This evil will be regulated by legislation.

The practical solution of an interesting geological question is credited to Nordenskjold, the Swedish scientist, in showing that water can be found by boring into granite and other crystalline rocks, to a depth of from 100 to 170 feet; briefly, he proceeded on the theory that the variations in temperature ought to cause shearing strains between the upper and lower layers of the rock, in such way causing horizontal crevices into which water from the surface would percolate, and the water would also be fresh. A well was sunk in the islet of Arko, off the Swedish coast, in 1894, and at the depth of 110 feet fresh water was found, supplying 4,400 gallons a day, and, since then, six other wells have been bored, and water found at about the same descent, the object of the research being to provide lighthouses and pilot stations with a permanent and plentiful water source.

From statistics regarding coal production in the United States during the year 1895, compiled by Statistician Parker, of the Geological Survey, it appears that the total output for the year was 171,804,742 long tons, having a total value at the mines of $197,572,477, an increase over the production of 1894 of 19,350,000 long tons, and an increase in value of about $11,500,000. The output on anthracite coal in Pennsylvania increased from 46,358,144 long tons in 1894 to 51,785,122 long tons in 1895, a gain of over 5,400,000 long tons. The value increased only about $3,500,000—from $78,488,063 to $82,019,272—showing that anthracite coal was cheaper in 1895 than in 1894. The product of bituminous coal increased from 118,820,405 short tons of 2,000 pounds in 1894 to 134,421,974 short tons in 1895, a gain of over 15,500,000 tons. The value increased about $8,000,000. There was an increased production in all but five of the twenty-nine coal-producing States.

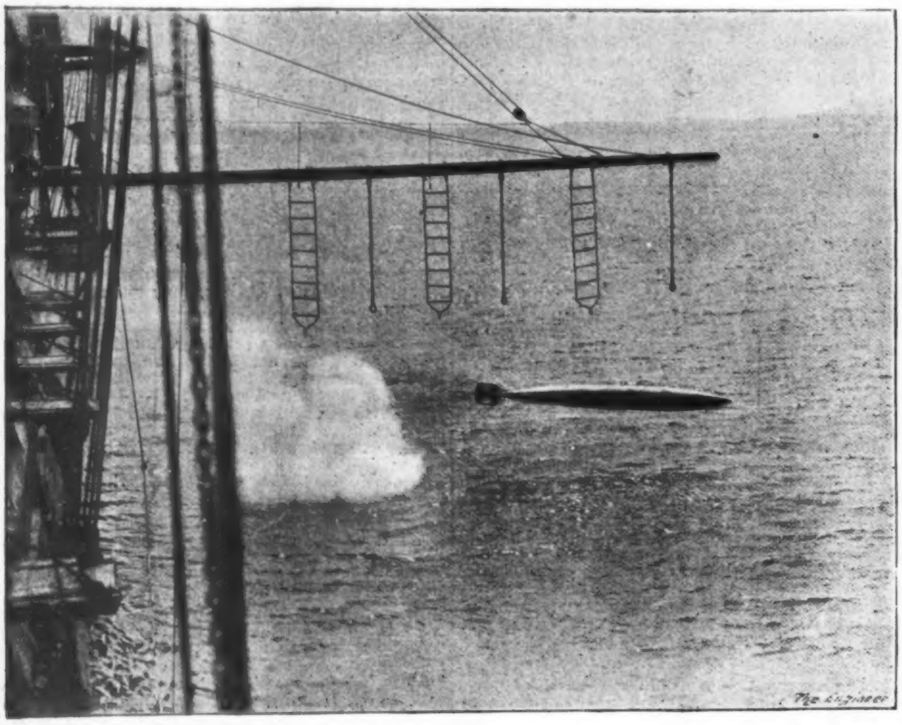
According to a communication in one of the German journals relative to the new paper invented by John Schultz, of Lautenberg, West Prussia, the manufacture of which has been prohibited by government authority, the paper is composed of glue, asbestos and the ordinary ingredients used in the production of such material. The moist sheets, immediately after leaving the rollers for the first time, are placed in a bath of concentrated sulphuric acid, to which some ten or fifteen per cent. of distilled water has been added, and which must be kept at a temperature of 20° R. According to their thickness, the sheets are left in the liquid five to thirty-five seconds. After having been pressed between glass rollers, they are put into pure water, next into a solution of ammonia, and finally into water again, such process being followed by hard pressing, passing through felt rollers and drying between polished and heated metal cylinders. The paper resulting from this process has the appearance and properties of ordinary note paper, but it is stated that even the most acid ink can easily be washed off with water after any length of time, and on account of this quality its manufacture is under governmental interdict.

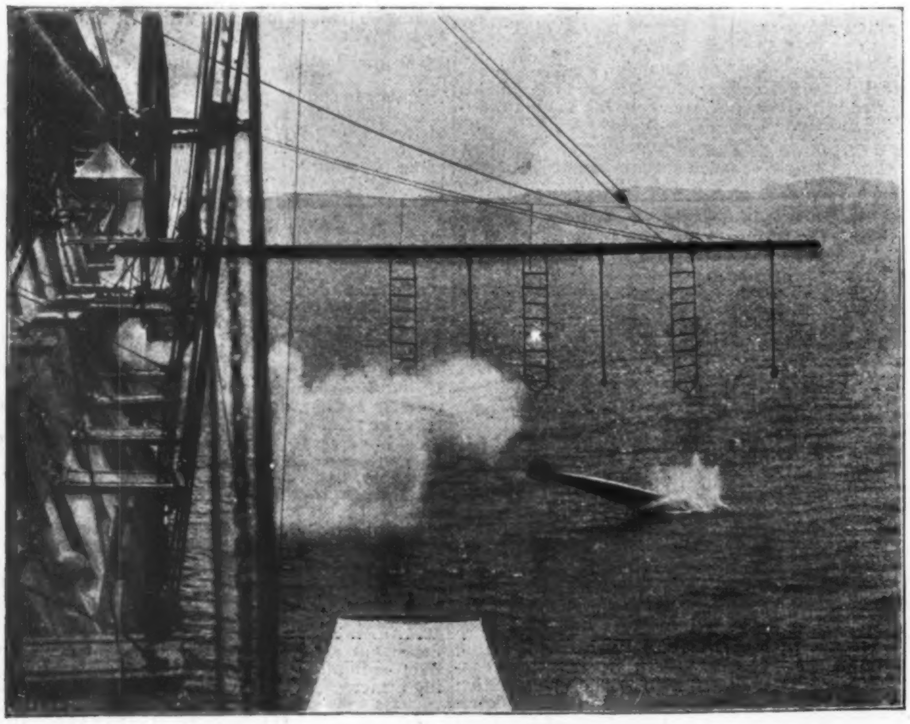
MODIFICATIONS IN THE DESIGN OF DESTROYERS.

THE great speed with which our flotilla of torpedo boat destroyers has been got together will account in some measure for the number of breakdowns which have taken place, and for the considerable modifications in design which are observable in the new vessels now being brought forward. Many of the difficulties which have been encountered are due, we cannot but think, to the stringency of the Admiralty conditions in regard to weight of propelling machinery and fixed displacement.

One of the most important and valuable modifications which have been effected is the abolition of bow torpedo tubes. The torpedo armament of these vessels is now confined to two torpedo guns of twin tube character, which are worked from the deck. It was altogether a mistake giving the destroyers a bow tube. The effect of this singularly illogical contrivance, which we should be glad to see removed from our war vessels altogether, was to create in front of the earlier boats of the class under consideration an enormous bow wave when the speed exceeded 22 or 23 knots, and in a heavy sea with headwind, the violent blows which the bows received from the waves not unfrequently forced the door open, allowing water to enter and fill the fore peak. But there was another and more cogent reason for the abandonment of the bow tubes. It was feared that there was a chance of the torpedo being overrun during an action if the destroyer was steaming fast and discharged one of these missiles from her bow tube. In engaging an enemy the vessel would presumably be kept running at full speed, but as the extreme speed of an 18 inch torpedo is only somewhat in excess of 28 knots, there would be every probability of its being overtaken by the boat, for the following reason. The torpedo does not start upon its run in a horizontal straight line, but in an undulating line, and the waves of this line gradually straighten out as the torpedo proceeds on its course. No matter how horizontally the torpedo is launched, it deflects at an angle when it touches the water, owing to its inclination to turn a somersault upon its head as the latter enters the denser medium. This sets up the wave action. The accompanying engravings, which are taken from two striking photographs published by Mr. West, of Southsea, show the movement very clearly. Though the torpedo has been launched almost horizontally, as seen in our first picture, the second shows it entering the water at an obtuse angle to its original course. In the engraving the vessel is seen to be at rest. But it is needless to say that the wave action would be greatly enhanced in the case of a torpedo leaving the bow tube of a vessel steaming at 27 or 28 knots. In such a case the tendency of the tail end of the torpedo to turn over, so soon as the head entered the water, or denser medium, would be so great that the undulations of the torpedo, at starting under water, would seriously affect its speed. The danger of overriding would therefore be imminent. This is not a theoretic danger. Quite recently a large war vessel of high speed, after discharging a torpedo from her bow tube, overran it, struck it, and the air chamber exploded beneath it with great violence. The war vessel's skin was too stout to be affected by the explosion, but the incident sufficiently illustrates the importance of the argument. Had the torpedo been a charged one, the war vessel would have been sunk, and in the case of a "destroyer," the accident might possibly have been fatal, whether the torpedo was charged or not.

The "sitting down" of the earlier torpedo boat destroyers in the water, when running at high speed, has been modified to a great extent by hollowing out the run beneath the counter until it presents a completely flat surface to the water it is gliding over. This is a perfect remedy in a smooth sea, or even when it is blowing a little and the wind is on the beam. But when a severe head gale is encountered, and the little craft is pitching and scending, the greatest care has to be exercised in so heading the vessel as to prevent her counter flogging the sea when she comes down aft. There is, in fact, considerable danger of her frame being injured by the blows which she receives below her stern. This is a point only fully realized by naval officers who have had experience of these boats during a gale in a seaway, and not one of which shipbuilders are likely to know much. But it is an important one, and its recognition is imperative.—The Engineer.





TORPEDOES IN FLIGHT.

THE PANHARD-LEVASSOR ROAD MOTOR.

WHEN, nearly two years ago, the now famous competition between various systems of mechanically propelled road carriages took place in France, among the comparatively numerous vehicles that were entered for the race, there were, besides those of Peugeot and Le Blant, which we have already described, four constructed at the works of MM. Panhard and Levassor. Of these, three were built to carry four passengers, the fourth one having only two places; all of these carriages were propelled by gasoline motors. As we have seen on a previous occasion, all these vehicles made an excellent record, and since then other carriages by the same makers, but considerably modified and improved in their details, took a distinguished part in the competition of last summer.

We propose in this series of articles on the road motors of French makers to consider next those constructed on the Panhard-Levassor system. The first prize in the Paris-Rouen competition was divided between MM. Panhard-Levassor and M. Peugeot. The vehicles which had gained this distinction for the first named makers included one of four and one of two places; the latter being illustrated by Fig. 1.

Both carriages ran the distance between Paris and Rouen in less than eleven hours. In all cases the competing carriages were driven by a gasoline Daimler motor, and it is this type of engine that MM. Panhard and Levassor continue to employ, although in a form modified since the time of the first trials in 1894. It may be convenient to describe them as they existed at that time and then to point out the changes that have since been made. The several views, Figs. 3, 4 and 5, respectively a longitudinal section, a transverse section through the engine space, and a plan, illustrate the arrangement very clearly. The type of 1894 comprised a strong iron and wooden frame mounted on four wheels, with springs interposed; the mechanism is carried on this frame in the manner shown in the various engravings. The accommodation for passengers is ample and convenient; the carriage body is fastened to the frame by means of four bolts, but it can be readily removed to give access to the mechanism, for cleaning or repair.

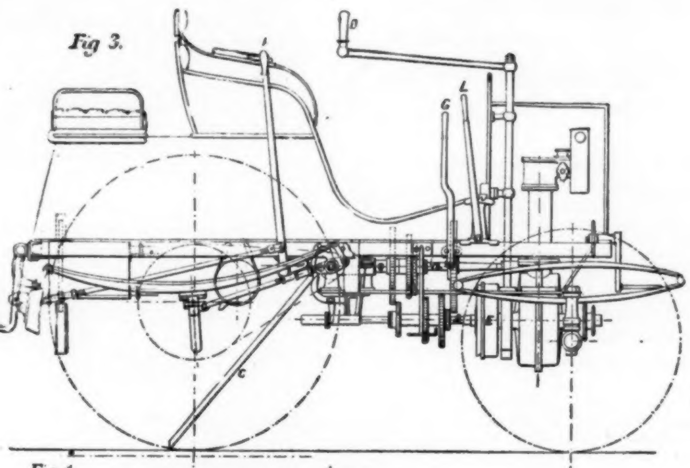
The wheels are of wood, with tires either of flat iron or of iron protected by rubber. It may be remarked here that in the type we are just now referring to, and which is nearly two years old, the wheels are of the form shown in the lighter two seated carriage, and not like those in the fourplace one. This form of construction, in which a toothed wheel is attached by bolts to each spoke, will be explained later. The same arrangement is shown in Figs. 3, 4, and 5, and represents a system of control which had not been worked out in 1894.

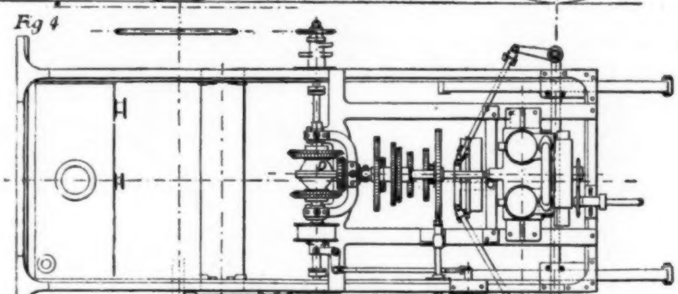
As will be seen, the motor is placed in front of the carriage, contrary to the arrangement adopted in the Peugeot system. This position does not appear to present the same advantage as that used by MM. Peugeot, who prefer to put all the available weight near the driving axle, and it would seem likely that the smell of the benzolene would be less perceptible when the motor is placed at the rear. MM. Panhard-Levassor, however, consider that there is a balance of advantage in the arrangement they have chosen, and they use it in all their vehicles. As we already said, the motor is on the Daimler system. It has two cylinders, the axes of which are on the same plane, but converge so as to inclose an angle of about 15°, in Fig. 5. It is inclosed within a box, the sides of which are provided with movable shutters, so that access is easy on different sides. In this motor the downstroke of one piston corresponds with the upstroke of the other; the driving shaft has only one crank, the disk sides of which serve as flywheels. The crank is inclosed in a tight box, and is kept oiled by the overflow of the cylinder lubrication. The firing of the explosive mixture is effected by means of platinum tubes, kept incandescent by burners placed below; these burners are supplied with spirit from a special reservoir filled automatically when the main reservoir is charged. The engine is driven at a constant speed of 700 revolutions per minute; this rate can, however, be reduced by a regulator that operates by checking the flow of the exhaust. There is also within reach of the driver a lever that shifts the slide valve, and by modifying the exhaust passage, reduces the speed. The explosive mixture supplied to the cylinders is prepared (in the 1894 model) in a carburetor in which a float cuts off from the main body of the gasoline an always constant quantity. The air drawn in by the motor has to pass through this mass of spirit; it then flows through a wire gauze screen which arrests any liquid particles that might otherwise be drawn over, and then through a threeway tap, on its way to the cylinder. By means of this tap the amount of air added to the carbureted mixture can be regulated. The cylinders are kept cool by a water circulation; the supply is kept in a tank holding seven or eight gallons; it is made to circulate by means of a centrifugal pump, and is cooled by a condenser placed beneath the carriage body; the supply carried is sufficient to last without renewal for 40 or 50 miles. The pump is driven by a friction disk on the driving shaft. From the foregoing brief description it will be seen that the general features of the motor used by MM. Panhard and Levassor are very similar to those in the Peugeot system which we have already described.

The movement of the driving shaft is transmitted by a friction clutch to a second shaft forming a prolongation of the first. This clutch is shown at E (Figs. 3 and 4).

By means of this device, the same advantage is gained as in the Peugeot system; that is to say, the motor can be started without at the same time putting

the shaft, A, in movement, and the transmission to the driving gear can be effected gradually and without shock. The general form of the clutch is shown in the drawings; each of its two parts consists of two cones on the same axis, the outer one having a sharp angle, the inner one an angle of 45°; the latter rests through springs on the support of the outer cone. On the transmission shaft, A, which is an extension of the crank shaft, there is a sleeve carrying three toothed wheels separated from each other, much in the same way as in the Peugeot system. These wheels gear into one or other of the different toothed wheels mounted on a third longitudinal shaft, a, and in this way a series of speeds can be obtained. The wheels with the sliding sleeve, which is prevented from turning by a key, are moved to and fro by a controlling lever shown at G, Fig. 3. In this way three different speeds are obtained, the minimum, intermediate, and maximum, corresponding respectively to rates of about 4, 8, and 12 miles per hour. The device is so arranged that it is not possible to pass from one rate of speed to another without the wheels being thrown entirely out of gear before a new speed is given, so that, as in the Peugeot system, the driving and intermediate shafts are disconnected before the gearing can be modified.

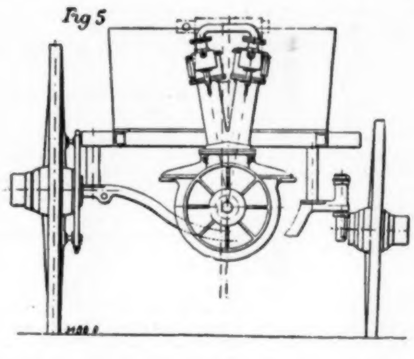




With respect to the transmission of the movement of the shaft, a, to the two driving wheels, the method adopted in the 1895 model, and illustrated in Fig. 2, differs considerably from that used in the 1894 pattern. In both the shaft, a, has on its rear end a bevel pinion gearing into bevel wheels, and so changing the direction of motion; but in the 1894 type this bevel pinion always drives the wheels that gear into it, and which are loose on a transverse shaft, placed in a position corresponding to D, in Fig. 4. Between these wheels a sleeve clutch slides on the shaft, and by throwing this to the right or left, one or other of the bevel wheels is in gear with the pinion, and a forward or backward direction can be given to the carriage. There is no differential movement on the transverse shaft in this arrangement, and motion is transferred to the driving wheels by a pitched chain passing over grooved wheels on the rear axle, and over drums keyed on the ends of the transverse shaft (see Fig. 3). The differential movement necessary to secure independent action of the driving wheels is on the rear axle. In this arrangement the axle revolves, and is connected to the suspension springs by means of boxes as in railway wagons. The method of steering this vehicle is peculiar, and it is first necessary to refer to the construction of the fore carriage, which is illustrated in Figs. 3, 4, and 5. It is of the Jeantaud divided axle type, already described (see Engineering, vol. lx, page 502). The front axle is fast with the frame, and the wheels turn on it on two vertical axes, the displacement being controlled by the movement of bell cranks (Fig. 4), actuated through the steering lever, B, the upper end of which is in front of the conductor, and a little to his left hand. The constructors are well satisfied with this steering gear, although it is urged against the arrangement that it transmits violent shocks to the man steering. Opposite the conductor is the lever of the threeway valve which regulates the admission and density of the carbureted air flowing to the motor; on the right is the reversing lever, L, Fig. 3, which, in the 1894 model, operates by shifting the sleeve clutch to the right or left, as already described. The speed regulating lever is shown at G, and F is the brake lever placed beside the conductor's seat. There is also a second strap brake, which can be put on by a pedal near the conductor's seat. Shoe brakes are obviously undesirable for use on rubber tires, although these are employed to some extent, the blocks being made also of rubber. The two brakes are coupled with the gearing in such a way that it is impossible to throw them in action while the motor is in gear. So soon as the pedal or lever has been depressed, the clutch is thrown out of gear automatically, so that the conductor is not obliged to pay any attention to this point. This 1894 carriage gave considerable satisfaction; the mode of operation is as follows: Before starting, the burners are lighted, and the motor is turned by hand by means of a crank in front of the carriage (Figs. 3 and 4), the admission of carbureted air is regulated, and in five minutes the machine is ready.

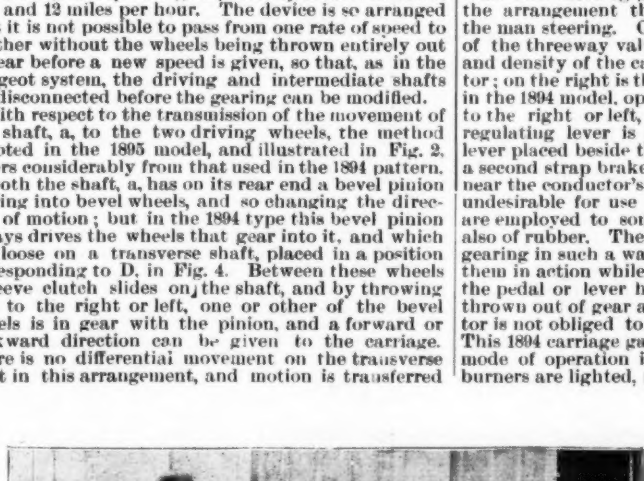
Stoppages every three or four hours suffice to renew the water required to cool the cylinders, and at the same time to inspect the mechanism; on stopping, the supply of carbureted air is cut off, the burners are extinguished, and a small quantity of petroleum is placed in the cylinders to keep them clean. The continuous system of lubrication used on this model is very efficient. Several different carriages of this type have been built with motors of from 3·3 to 3·7 horse power. As to the weight of the vehicle, it varies from 1,100 lb. to 1,540 lb. in working order; the lighter weight is that of a two-seated carriage, and the heavier of one with four places. The cost of working is always difficult to ascertain; the estimate of 1894 was less than one quart of spirit for seven miles traveled, and the consumption of cooling water was about two gallons per hour.

Fig. 2 illustrates the carriage that made the best time in the Paris Bordeaux race. The general appearance suggests weight and lack of elegance, and offers a contrast in this respect to the lighter and more graceful designs of Peugeot. But for all this it gave satisfaction, and a diagram of the speed would show great uniformity and steadiness. Of the three Panhard-Levassor types, that of the two seated carriages weighs 1,380 pounds, has a three horse power motor and a transmission gear giving three speeds of 4·5, 10 and 15·5 miles per hour. The road car with four seats has a motor of three horse power and transmission gear



giving three speeds—3·7, 7·5 and 15 miles an hour. The differences in the 1895 type are chiefly as follows: There is a new pattern of carburetor with automatic regulator; two chambers are employed, the first of which contains the spirit kept at a uniform level; the second is an air chamber communicating with the motor. A tube from the bottom of the spirit chamber is taken vertically into the air chamber, terminating in a fine nozzle; at each stroke of the motor a jet of spirit is induced into the air chamber, the air becoming carbureted and passing off to the cylinders, being heated on the way. The degree of carburetion is regulated by adjusting the jet. The motor has been considerably modified, chiefly with the object of reducing weight per horse power.

In the earlier form the diameter of the converging cylinders was 2·95 in. and the length of stroke 4·72 in. The latter has been increased to 5·51 in., the diameter remaining as before; by this change an increased power with the same weight has been obtained. The cylinders are now placed parallel to each other, the piston rods being connected to the same axle; the stroke is, as we have said, 5·51 in., and the running speed is over 800; the power developed with this latest model is four horse power. At the same time the bulk occupied is less, so that it is more conveniently attached to the carriage and the weight is only 182 pounds, instead of nearly double, as in the older types. The shaft, a (Fig. 3), is now extended, and terminates with a coned pinion which gears into one or other of a pair of bevel wheels, according to whether these wheels are shifted laterally, this movement being obtained by means of the reversing lever. Moreover, between this system of bevel gear a differential movement, D (Fig. 4), has been introduced. The rear axle of the carriage is fixed and the revolutions of the motor are transmitted by the countershaft. The driving wheels are



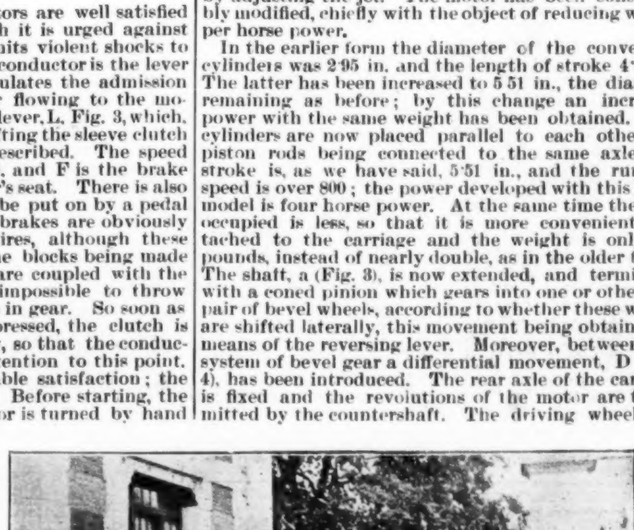


FIG. 1. THE PANHARD-LEVASSOR SYSTEM OF ROAD MOTOR CARS. FIG. 2.

actuated by means of toothed wheels placed at the ends of this shaft and from which the pitched chains (of which there is one at each side of the vehicle) pass over toothed rings bolted to the wheels, which are made of wood. The mode of attachment is shown in Fig. 2, and it will be seen to consist of bolts passed through the spokes and the ring. The illustration, Fig. 2, shows the wheels with rubber tires, but MM. Panhard and Levassor also use iron tires. The gear throughout is protected as far as possible by being closely boxed in.

The water tank is placed at the back of the carriage, and beneath it is the waste water tank. It will be noticed that a crutch, C, is attached below the frame. This is found useful occasionally to skid the carriage in stopping on steep inclines when the brakes are insufficient.

MM. Panhard and Levassor are, relatively, large manufacturers of mechanical road cars, from light two seated carriages to omnibus and goods delivery wagons. They claim that the cost of running a vehicle of average weight does not exceed a penny a mile, but it is not quite clear how many items beyond oil and lubrication are included in this estimate.—Engineering.

[Continued from Supplement, No. 1068, page 17067.]

NOTES ON STEAM SUPERHEATING.*

By Mr. William H. Patchell, of London.

McPhail and Simpson's Superheater.—This apparatus is the invention of Mr. Hugh McPhail, and is manufactured in Wakefield by McPhail and Simpson's Dry Steam Patents Co. It consists of two parts: the superheater proper and the steam generator of radiating tubes, which distinguishes it from all other plants. As applied to a Lancashire boiler, Figs. 5 and 6, there are two nests of vertical steel tubes expanded at top and bottom into cast steel boxes, or "headers," as they are called in water tube boilers; these nests are placed preferably at the back end of the internal flues of the Lancashire boiler, in the downtake, where the furnace gases impinge on them and pass between them. One of the top boxes is connected to the usual anti-priming pipe in the boiler; and the corresponding bottom box is connected to a block, which passes into the bottom of the boiler, and from which a copper pipe runs along the bottom of the boiler under the internal flues to the front end, and thence back again to the rear, where it passes out of the boiler and into the other bottom box. The second top box is connected to another copper pipe, which runs along the boiler over the internal flues, just below the water line, and ends at the main steam stop valve. The course of the steam is from the antipriming pipe to the first top box, then down the superheating tubes to the first bottom box, whence it enters the boiler, and, passing through the lower copper pipe, gives up part of its superheat to the surrounding water before leaving the boiler and entering the second bottom box. It is then further superheated in passing up through the second nest of tubes; and thence passing through the second top box into the upper copper pipe in the boiler, it again parts with some of its superheat before finally leaving the boiler at the steam stopvalve. The complete apparatus thus consists of two external superheaters and two internal radiators; and the final degree of superheat depends upon the proportion of the superheating tubes to the radiating pipes; the function of these radiating pipes is most important, as they give off to the water in the boiler the superheat which might be dangerous in the engines in times of heavy firing; and when the fires are green after cleaning and the flue gases low in temperature, they prevent any possibility of the superheater becoming a condenser. They thus tend to keep regular the amount of superheat in the steam as it leaves the boiler. It will be evident, therefore, that this superheater may be arranged either for improving the evaporative efficiency of a boiler, and at the same time giving dry steam at the engine, or for the steam to leave the boiler highly superheated. In its complete form this superheater has been tested and fully reported upon by several engineers in this country, among whom may be mentioned Messrs. Crosland and Michael Longridge. In Table III are given the results of some recent tests, one made by M. Armengaud at the works of Messrs. Isaac Holden and Son, Reims, and others at Kinleith and Thornliebank, for which the author is indebted to the manufacturers.

Table III.—*Boiler Tests without and with McPhail and Simpson's Superheater at Messrs. Isaac Holden and Son's Works, Reims.*

Lancashire boiler 28 ft. long and 8½ ft. diameter, with two internal flues 3 ft. 3¾ in. diameter; heating surface, 1,012 square feet; grate area, 39 square feet; supplying steam to a Corliss engine. Quality of fuel, Dourges.

	Without or with superheater.	Without	With.
1	Date, 1894	June 20	June 2
2	Duration of trial, hours	7·83	8
3	Average boiler pressure per sq. in. above atm., lb.	73·6	91·5
4	Temperature corresponding with pressure, Fah.	318·7°	331·6°
5	Temperature of steam leaving boiler, Fah.	—	388·1°
6	Degrees of superheat, Fah.	—	56·5°
7	Average temperature of feed-water, Fah.	117½°	119°
8	Water evaporated, total during test, lb.	49,899	47,096
9	„ per hour, lb.	6,373	5,887
10	„ „ per sq. ft. of grate, lb.	163·4	151·0
11	„ „ per sq. ft. of heating surface, lb.	6·29	5·81
12	Coal burnt, total during test, lb.	7364·7	5435·3
13	„ per hour, lb.	941	679·4
14	„ „ per sq. ft. of grate, lb.	24·13	17·42
15	Ash and clinker, total, lb.	937	613
16	„ percentage of coal, per cent.	12·75	11·3
17	Combustible burnt, total, lb.	6427·7	4822·3
18	Water evaporated per lb. of coal, lb.	6·78	8·66
19	„ „ combustible, lb.	7·76	9·76
20	Average indicated horse-power, I.H.P.	328·3	328·5
21	Coal per I.H.P. per hour, lb.	2·86	2·10
22	Water per I.H.P. per hour, lb.	19·41	18·19
23	Gain in coal per I.H.P., per cent.	—	36·2
24	„ water per I.H.P., per cent.	—	6·8
25	„ „ evaporated per lb. of coal, per cent.	—	27·7
	Equivalent evaporation from and at 212 deg. Fah. Superheat neglected		
26	Water per lb. of coal, lb.	7·69	9·81
27	„ „ gain per cent.	—	27·5
28	Water per lb. of combustible, lb.	8·80	11·05
29	„ „ „ gain per cent.	—	25·5
	Superheat included.		
30	Water per lb. of coal, lb.	7·69	10·07
31	„ „ gain per cent.	—	30·9
32	Water per lb. of combustible, lb.	8·80	11·35
33	„ „ „ gain per cent.	—	28·97

* Paper read before the Institution of Mechanical Engineers, January 31, 1895.—From the London Engineer.

The Reims tests, Table III, were made before and after the apparatus was fixed on a Lancashire boiler 8½ ft. diameter and 28 ft. long, with furnace tubes 3 ft. 3¾ in. diameter. The heating surface is 2,287½ square feet and the grate area 39 square feet. The steam was used exclusively for a simple Corliss condensing

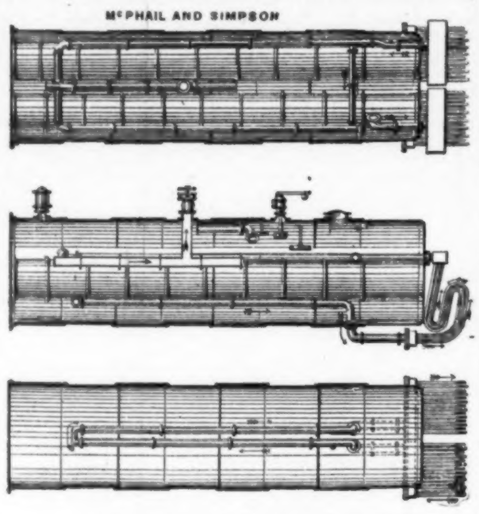


Fig. 5.—McPHAIL AND SIMPSON.

engine, with cylinder 28 in. diameter and 4½ ft. stroke, running at sixty revolutions per minute, driving the machinery in a wool combing mill. The work was arranged so that it should be as nearly as possible equal on the occasion of each test. Owing to an oversight during the test made before the superheater was fixed, the feed was left on while the boiler fires were being cleaned, the usual custom being to raise the water level before cleaning and then stop the pump. The result was a fall in the steam pressure from 78 lb. to 42½ lb. per square inch; and the boiler was so fully loaded that it took two hours to recover the normal pressure. The speed of the engine fell to fifty-eight revolutions per minute, although the trips on the Corliss gear ceased to act and full steam was being taken for nearly an hour; fifty-nine revolutions per minute were made for a further half hour, before the usual speed was re-established. During the second test the same procedure was intentionally repeated, in order that both tests might be exactly compared; the result was that the steam pressure fell only 3½ lb. and the speed was not affected at all. This difference is most striking, and is a forcible proof of the great increase in the capacity of a boiler when fitted with the superheating apparatus. The superheat was measured at the boiler stop valve, and was almost constant at 56 deg. Fah.

Schwoerer's Superheater.—The superheater illustrated in Figs 9 to 11 is the invention of Mr. Emile Schwoerer, of Colmar, Alsace, who was for some time private secretary to the late Mr. G. A. Hirn. It was Mr. Hirn who first took up superheating seriously; and it is due to his energy that so much has been done with it in practical working in Alsace. Mr. Schwoerer's improvements were in the direction of reducing the space occupied by the apparatus; and he attained this end by employing a coil of pipes with gills on them both inside and outside, thus getting large surfaces in a small bulk. Regulation of the superheat by deflecting the hot gases away from the tubes, rather than by varying the proportion of the total steam passing through the tubes, is due to Mr. Schwoerer, though this regulation does not appear to have been generally carried out. By the courtesy of Prof. W. Cawthorne Unwin, the author is enabled to give the tests in Table IX of Schwoerer superheaters in Alsace, some of which were carried out by himself and others by Mr. Walther Meunier, engineer in chief of the Alsatian Association of Steam Users. It will be noted that in tests 1, 3, 5, 9 one more boiler was required to do the work when saturated steam was being used at the engine. The boilers were of the elephant kind, with Green's economizers.

An application of the Schwoerer superheater has been made by Messrs. James Simpson & Co. to a Babcock & Wilcox water tube boiler at the Grand Junction Waterworks, Kew. The arrangement is shown in Figs. 9 to 11. The boiler is of the same size as those fitted by the author with McPhail's apparatus at Maiden Lane. Full details of the trials unfortunately cannot be obtained, but the saving effected is satisfactory. Tests were conducted by Mr. Osbert Chadwick before and after the superheater was fixed, with the following results. Table X.

A test was also conducted by Mr. Goodman, the superintending engineer at the pumping station, under ordinary working conditions from December 8, 1894, to January 5, 1895, the engine and boiler being kept

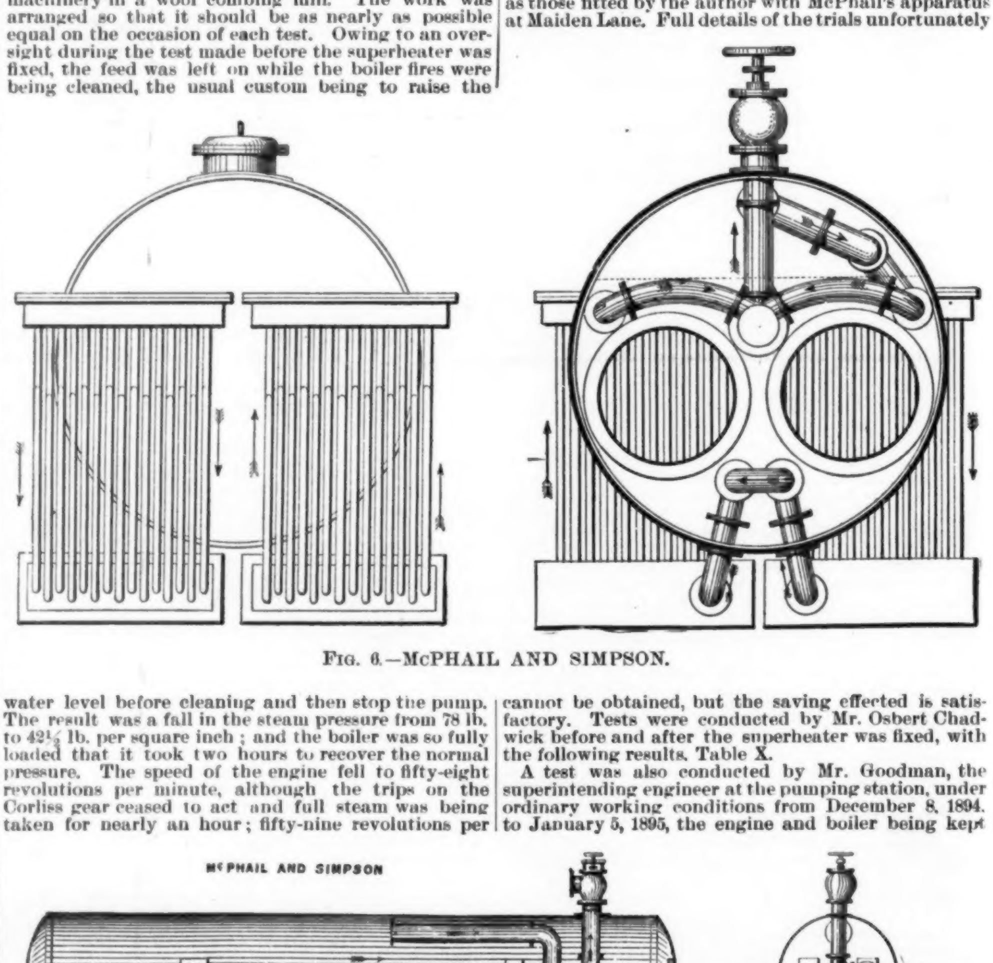
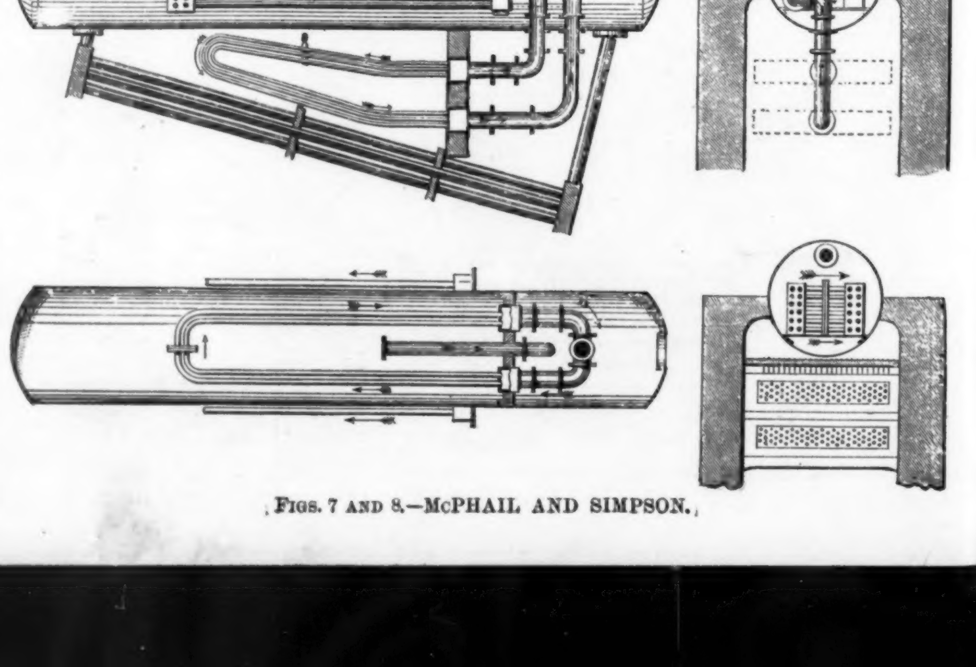


Fig. 6.—McPHAIL AND SIMPSON.



Figs. 7 and 8.—McPHAIL AND SIMPSON.

TABLE X.—*Boiler Tests without and with Schwoerer's Superheater.*

Date	Jan. 21, 1893	Dec. 20, 1893	Feb. 22, 1894	Mar. 13, 1894
Degrees of superheat, deg Fah.	0	57·7	100·5	57·0
Steam per pump H.P. per hr., lb.	20·98	19·71	18·75	19·48
Saving effected, per cent... ..	—	6·05	10·63	6·75

TABLE IX.—*Boiler Tests without and with Schwoerer's Superheaters.*

Tests made by	Mr. Walther Meunier.								Professor Unwin.			
No. of test	1	2	3	4	5	6	7	8	9	10	11	12
Without or with superheaters ..	Without	With	Without	With	Without	With	Without	With	Without	With	With	With
Number of boilers in use	3	2	4	3	4	3	1	1	4	3	3	3
Duration of trial, hours and minutes	11—10	11—0	10—24	10—19	11—30	11—30	11—30	11--30	6—0	5-0	6—0	5—0
Mean indicated horse-power ..	278	276	554	564	810	809	116	119	475	491	501·4	502·3
Steam per I.H.P. per hour, lb...	19·8	17·1	21·87	17·44	19·00	15·70	21·6	19·2	19·75	15·63	17·06	15·61
Coal per I.H.P. per hour, lb. ..	3·16	2·37	3·78	3·01	2·98	2·38	3·45	2·64	3·15	2·59	2·56	2·51
Boiler pressure above atm. per square inch, lb.	—	—	86·7	86·7	68	65	—	—	95·72	99·05	93·74	94·00
Deg. of superheat at valve chest	—	115°	—	102	—	118°	—	—	—	118·2	119·2	126·9
Economy in coal, per cent. ..	—	25	—	20	—	20·7	—	23·5	—	17·6	18·5	20·1
Economy in steam, per cent. ..	—	14	—	20	—	17·4	—	11·0	—	20·9	18·6	20·9

continually at work. The fuel used was 86·98 per cent. anthracite pea and 13·02 per cent. breeze, the draught being assisted by a Meldrum blower. The results then obtained were:

Duration of trial	723½ hours.
Feed water per hour...............	3223 lb.
Fuel per hour	471 lb.
Steam per pump horse power per hour............	17·74 lb.
Fuel per pump horse power per hour..........................	2·58 lb.
Mean superheat	121 deg. Fah.

These results showed a saving of about 15 per cent. on what had been obtained before the Schwoerer superheater was fixed. This type of superheater is also made by Messrs. Fraser & Chalmers, Erith, who have one in constant use at their works.

Sinclair's Superheater.—Another form of superheater is shown in Fig. 12, which is due to Mr. George Sinclair, of Leith. There is here a departure from the

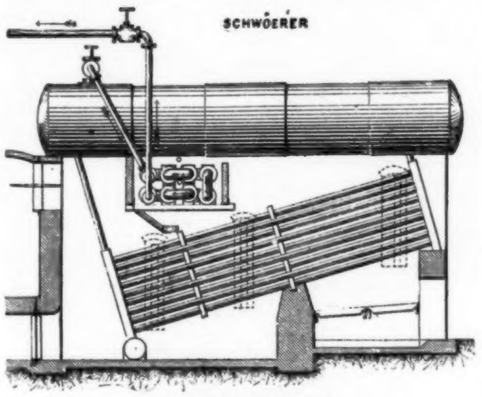


FIG. 9.—SCHWOERER.

usual method of securing the tubes, which in this apparatus are flanged and bolted to the cross inlet and outlet pipes, instead of being expanded into them. In such positions an expanded joint is generally considered desirable, but here the joints are removed from the action of the hot gases, and a bolted joint gives much greater facilities for removing a tube in order to examine or clean it. In Fig. 12 the apparatus is shown

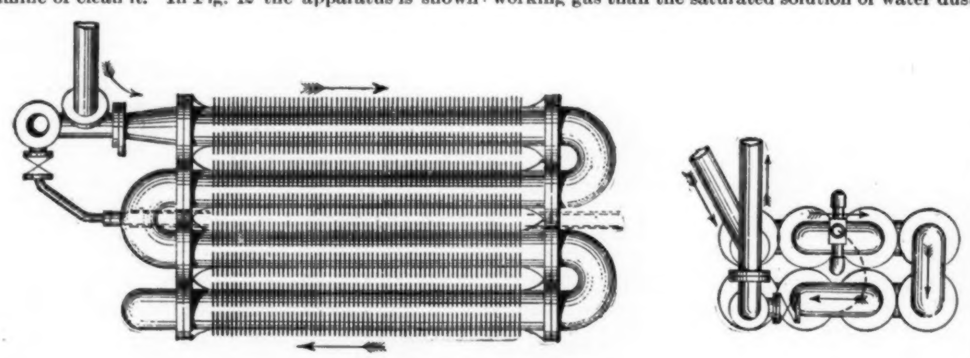


FIG. 11.—SCHWOERER.

in conjunction with a marine dry back boiler, as fitted by Prof. Kennedy at the Edinburgh electric lighting station. The arrangement is very compact, and should prove highly economical. The hot gases from the smoke box at the front are led to the back over the top of the boiler, passing among the superheating tubes, thence down the sides of the boiler to the center flue underneath it. The apparatus was described in

Mr. Burstall's paper read at the last meeting—October, 1895—and in the discussion Prof. Kennedy stated that further tests were then in hand; the author would be very glad if the present should be considered a convenient opportunity for publishing the results of them.

It is much to be regretted that so little has been done as yet with superheated steam at the engine. In nearly every instance the superheat appears to be

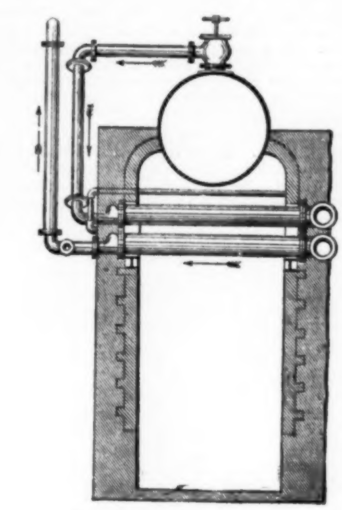


FIG. 10.—SCHWOERER.

gone, if not at the steam chest, at any rate immediately on admission to the cylinder. But even under these circumstances the advantage of superheating is manifest from many of the tests given above; and it must be recognized that, although the steam may be cooled down again to the temperature corresponding with the pressure, it is still dry steam, and is a better working gas than the saturated solution of water dust

in the steam. This point has been brought out clearly by Mr. W. H. Booth, in his paper on cylinder condensation, read to the Manchester Association of Engineers a few months ago, wherein it was shown that the amount of superheat is but little in excess of that necessary to supply the heat required for making good the latent heat which disappears as work during expansion.

When preparing to respond to the request that he would contribute a paper giving his own experience with superheating, the author found that, although a great deal had been done, but little information on this subject was to be met with in the Institution "Proceedings." He has, therefore, endeavored to the best of his ability, during a particularly busy winter, to fill up the blank by collecting and recording all the data that he is himself possessed of. It is not imagined that the superheaters here described make up a complete list; and it is hoped that any which have not been included in the paper will be dealt with to better advantage by speakers in the discussion. The theory and advantages of superheating at the engine have not been touched upon, not only for want of space, but also in the hope that some member of the Institution who has given the subject much attention may be tempted to contribute a comprehensive paper thereon. In conclusion, the author desires to thank the several gentlemen and firms who have kindly given him information and plans.

supplied by an ordinary boiler. The desirable amount of superheat has been generally considered to be the equivalent of the heat lost by initial condensation; but this does not obtain in practice. The amount of heat lost in initial condensation is generally from 20 to 25 per cent. of the total heat of the steam above boiling point. Tests with superheated steam show a saving of 20 per cent., with only 5 per cent. extra heat

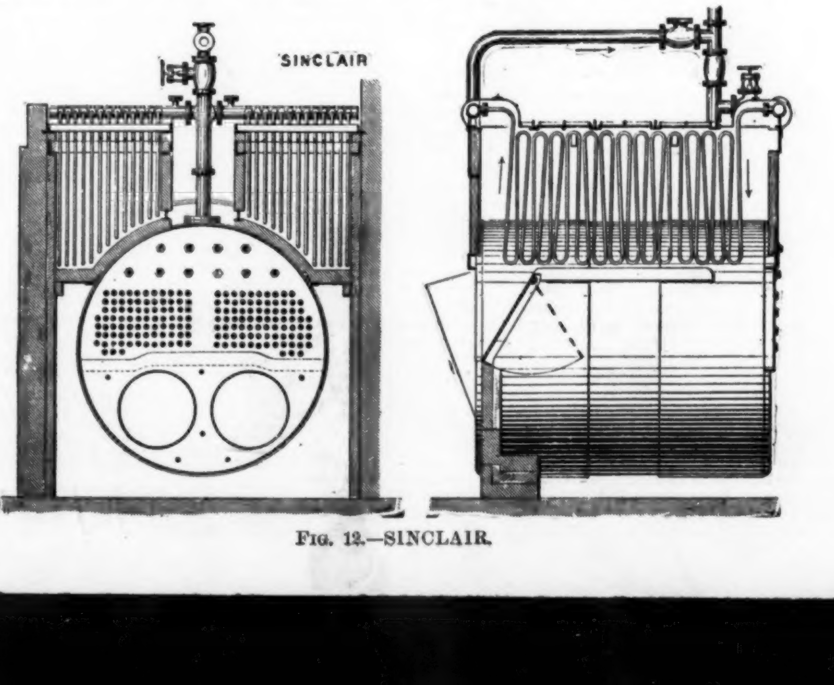


FIG. 12.—SINCLAIR.

A FIRST EXPERIMENT IN PHOTOGRAVURE.*

By Rev. F. C. LAMBERT, M.A.

THE following notes are put together with the chief aim of helping any reader who, knowing nothing whatever of photogravure, is wishful to know just enough about this beautiful process to enable him, unaided, to make a first experiment. In such a case to tell him all that might be said (were it even in the writer's power, which, happily for the reader, is not the case) would probably only tend to confuse him with a multiplicity of details of only secondary importance, at any rate for the first essays in this direction. And as it often is the case that some do not care to launch out into any great expenditure upon taking in hand a new process, an attempt will be here made to reduce, as far as may be, the outlay upon new tools, and in place trying to adapt some homely makeshift, until the tyro—having felt his feet—will be able as he gathers experience to select such items as may meet his growing needs.

The first thing is to get quite clear ideas in one's mind as to what we are wishing to accomplish. A homely experiment will start us on the right path. If we, with a knife, scrape a little fine black lead powder from a soft pencil and rub the tip of a finger into the black powder, and then with a bit of rag rub away from the black finger tip as much as we can of the adhering powder, we shall still have left some powder in the little furrows or grooves in the skin of the finger tip, and these showing as black lines. If now we take any bit of white paper and very slightly moisten it by breathing a few times upon it, and then press down the blackened finger tip on the paper, we shall get a print of the finger lines in black upon the white paper. Now, photogravure is an intaglio process whereby we make small holes in a copper plate. Ink is then rubbed all over the plate, and, of course, into the depressions; the superfluous ink is then removed, leaving some ink in the depressions. Damp paper is pressed upon the metal plate, and an "impression" (or cast in ink) is thereby obtained. Now observe that the deeper the holes which receive the ink, the more ink they will contain, while a very shallow hole will contain only a very thin layer. If this is only thin enough, the white paper will partly show through it, and consequently this part will not seem so dark as that corresponding to the deeper holes. Hence we conclude that the shadows of the picture correspond to the deeper holes and the lighter tones to the shallower holes, while the high lights receive no ink at all.

If now we write our signature on a piece of glazed paper, and, while the ink is still wet, we bring into contact with it a piece of clean blotting or other bibulous paper, we get an impression on the blotting paper which we are not easily able to read, because it is reversed, i. e., those letters which lean one way in the original lean the other way on the blotting paper, and in common phrase we have to read it backward, from right to left. If we hold this blotting paper before a reflecting surface, or mirror, it is again once more reversed and it reads the right way; while if we hold our original signature up to the glass, it becomes reversed and corresponds to the blotting paper impression. Hence we deduce the fact that contact reproduction means reversing the image from right to left. If we look at the copperplate from which our calling cards are printed, we find the writing (or engraving) reads from right to left and the letters slope the "wrong way," i. e., it is laterally reversed. Particular attention is drawn to this matter, because it is one which nearly always puzzles or confuses the beginner. The chain of steps may now be set forth:

(1) Our final print on paper is right way round, and being a contact print, must come from a reversed plate; therefore the copper is reversed.

(2) The copper is etched by means of a gelatine (carbon) negative laid down upon its surface. This negative is a contact print, but is developed (as carbon prints usually are) from the back, and is therefore re-

* From the Process Year Book for 1896.

versed in the operation. Therefore, if we regarded the contact side toward us, say before development, i. e., as it leaves the printing frame, it would be right side round.

(3) This carbon is a contact negative print right way round; therefore it must come from a reversed positive.

(4) This reversed positive cannot be made by contact from an ordinary glass negative, because the ordinary glass negative is reversed when looked at film toward the observer. If it were not so, it would yield a contact print right side round. Hence, the upshot of this matter is that we must (a) either start with a reversed or film negative to make a contact reversed positive; or (b) use the carbon process from an ordinary negative for the reversed positive; or (c) make a positive by copying through the camera an ordinary negative, taking the simple precaution of turning the film side of the negative away from the lens.

The order is thus: Ordinary negative reversed by turning round; a reversed positive or transparency, by copying through the camera; carbon contact negative right way when view contact surface to the observer; carbon negative on copper reversed by developing from the back; copper etched through reversed negative, yielding reversed intaglio plate; paper print by contact right way round.

CHOICE OF SUBJECT.

I would strongly advise the beginner to commence with a line subject. Select some engraving or woodcut print, say 8 × 6 inches in size, and of such character that the lines are fairly clear, and no large patches of strong dark or closely crossing lines. From this print make, in the usual way, a 4¼ × 3¼ negative, having clear glass for the lines, and a moderately strong density for the high lights. Fix up this negative film away from you against a window where you get skylight direct; or, failing this, where a sheet of white cardboard may be fixed outside at 45 degrees to the vertical plane—to act as a reflector, casting the light from the overhead sky through the negative. With a couple of thicknesses of brown paper cover the remainder of the window, and with a camera and slow plate make a positive from the negative. This should partake more or less of the same character as the negative just mentioned. If now we examine this positive by pressing it (when dry of course) film downward on a sheet of white paper, we have a reduction of the original subject now seen right way round.

THE COPPER PLATE.

The beginner will do well to buy a few specially prepared, i. e., polished, copper plates, and those of small size, say 4 × 3 or 3¼ × 2¼ inches, will serve well enough until experience is gained. Nor need these small plates be thicker than what is known as 18 gage. When received these plates have one side in a high state of polish, and some reasonable care must be taken to prevent this surface being scratched. If the surface shows any discoloration, i. e., patches due to oxidation of the copper, these may generally be removed by immersing for a minute or so in a very weak solution of nitric acid, say six or eight drops of strong acid per ounce of water. The plate is rinsed in clean water, to get rid of the acid, and then laid down on a piece of clean paper, and its bright surface polished by gently rubbing with a tuft of cotton wool (quite free from grit or grease) and a pasty cream made of washed whiting, and a ten per cent. solution of strong liquor ammonia, in clean boiled and filtered water. The mixture is applied in a thick creamy consistency, and gently and evenly rubbed until it dries, when a fresh tuft of cotton wool is taken and every trace of whiting is removed from its surface, edges, and back. This plate is now laid aside (in an empty plate box, for instance) and kept clear of dust.

THE CARBON NEGATIVE OR RESIST.

If the reader is familiar with working the carbon process, we may safely assume that he will follow the brief description of the next step. If, on the other hand, he has had no experience of this very interesting process, it must suffice to refer him to the many handbooks on this subject, or the guidance of a friend, for the more minute details of the matter. The following instructions should, however, be sufficient to serve for our present purpose. We require some sensitized carbon tissue, the color does not much matter, but the reds are perhaps as well avoided at first, as they are not very easy to see on the bright copper. The experienced hand will cut up and sensitize the tissue as required. In other cases it will be well for the inexperienced to buy it ready cut up and sensitized.* The tissue (which looks rather like patent leather on one side and paper on the other) should be kept in a fairly dry place and preferably flat, and when sensitized away from daylight, of course. But it may be safely handled in gas or diffused daylight coming through a yellow blind. The positive is first taken in hand, the size of picture determined upon, a mask is cut out of black or other opaque paper, leaving in our case say a rectangular opening of 3¼ × 2¼ inches. This mask or safe edge, as it generally is called, is attached by gum or paste to the glass side of the positive. The positive is now put into its printing frame, glass side with safe edge outward. A piece of carbon tissue trimmed down to be say $\frac{1}{16}$ of an inch smaller all the way round than the copper plate (i. e., 3⅞ × 2⅞ for a 4 × 3 copper) is placed in the frame, the dark shiny side in contact with the film of the positive, and is carefully arranged that the paper mask hides from the light an equal strip all the way round. With the above opening of 3¼ × 2¼ and a piece of tissue, size just mentioned, we should get a masked strip of $\frac{5}{16}$ all the way round. We now print this black tissue in daylight, but as nothing of the printing action is usually visible, we generally use an actinometer or "tinter." In this first experiment, we may extemporize and select from our stock of negatives some one which, as nearly as possible, corresponds in density and contrast to the positive now in use. Under this negative we place a bit of ordinary albumenized silver paper, and put the two frames out side by side. From time to time the silver print is examined, and just before the highest lights (i. e., through the densest parts) are showing, we remove the carbon print from the light.

MOUNTING THE CARBON ON THE COPPER.

Take a dish somewhat larger than the copper, say 6 × 4, and fill it to a depth of an inch or more with quite clean tepid water, and test the temperature with a thermometer. This should show 70° F. It is as well to avoid extremes, say 65° to 75° F. In the water lay your copper plate face upward. Remove the carbon tissue from the printing frame and dust off any particles of paper, etc. Avoid touching the bright dark surface as much as possible and slip it into the water, avoiding air bubbles. In two or three seconds turn it over and remove by means of soft brush any clinging air bells from back or front. At first the tissue will slightly curl dark side inward, but in a very short time, half a minute, perhaps, it will begin to straighten again. As soon as you see this take place bring together under water and avoiding air bubbles the dark surface of the carbon tissue and the bright surface of the copper, then gently raise the two together from the dish and drain off surface water, and pass over the paper back of the tissue a rubber squeegee, commencing in the center and working outward in all directions. The object is to bring the two surfaces into close contact, and expel any air bubbles and superfluous moisture. You may use reasonable pressure without doing any harm, but the backing paper should not be torn. The copper is now laid on the table, a piece of blotting paper applied and gently rubbed to remove surface moisture. It is now laid aside horizontally for say ten minutes. Meanwhile you may prepare the developing bath. For this all that is needed is a conveniently sized dish, say an eight by six or ordinary pie dish will serve. Water is now put in it of the temperature about 100° to 110° F. The copper, after drying for eight or ten minutes, is now laid at the bottom of the bath of warm water, paper side up. In the course of about a minute you will see some of the dark gelatine mixture beginning to ooze out between the copper and the paper; after another minute or so, you may take hold of a corner of the paper and gently raise it, finding it easily comes away from the copper, but leaves a dark mass behind. If it does not come away quite easily, give it a little more time and add a little more warmer water to raise the temperature two or three degrees. Having removed the backing paper, which has now done its work and may be thrown away, gently rock the dish for half a minute, and then raising the copper at one end, gently move it about under water, first raising one end and then the other. By this time much of the dark mass will now have melted away, and by moving the copper about in the warm water, presently the whole picture will come out in negative relief, i. e., the dark lines of the engraving are represented by the clear, or very nearly clear, copper, while the lighter parts of the original are represented by that part of the gelatine which has not dissolved away in the warm water. When development, i. e., solution of the soft gelatine, is complete, the copper is removed and gently rinsed in tepid, and finally in cold water, and then set up on edge out of the way of dust to dry. It is as well to rest its lower edge on a bit of blotting paper to absorb the moisture as it drains downward. In the course of an hour or so, the greater part will probably be dry, and you will then see the difference of appearance between the semi-transparent swollen and wet part and the more opaque contracted dry portions. The place of drying should not be too warm, otherwise the gelatine may dry unevenly and the film leave the plate. Again, the plate can be dried by chemical means, use of alcohol, etc., but the beginner is not recommended to adopt this method at first. But in any case the plate must be thoroughly dry beyond any doubt before etching is attempted, otherwise failure is inevitable.

PROTECTING THE PLATE.

As soon as the plate is dry, it is turned with its face toward the wall, and then to the back is given a thin coat of black varnish, thinned down with turpentine. This should be applied to the copper by means of a conveniently sized, soft haired paint brush. This backing will dry in a few minutes. The plate is now laid on a piece of paper face upward on the table, and the edges and the outer margin of the face (i. e., those parts that are not intended to be subjected to the etching fluid) are in like manner protected by a thin coat of black varnish. This may, in like manner, be applied with a steady hand, using either a small "liner" brush or ruling pen. You will have doubtless ere this observed that those parts of the tissue shielded from light by the safe edge or paper mask dissolved away, but it is due to this property that the parts inclosed by this safe edge stick firmly to the supporting material. And thus you will rightly conclude that all the parts of the copper represented by the safe edge margin are to be protected now by the black varnish.

PREPARATION OF THE ETCHING FLUID.

The mordant, biting, or engraving fluid generally used is a watery solution of iron perchloride, of strength approaching the saturation point. Having bought say three or four pounds of iron perchloride (a yellow stone-like solid) put it in a large earthenware jam pot or other similar vessel, and just cover with water and set on the hob or some warm place, occasionally stirring the mixture with a glass rod. In this way a saturated solution should be made and exposed in a warm place in an open vessel so that any free chlorine may pass away. Upon the degree or strength of the solution much depends in the etching, therefore it will be necessary to test this strength from time to time. This is most conveniently done by means of a Beaumé's hydrometer for heavy liquids (price about 2s. 6d.) The fluid to be examined is poured into a tall narrow glass vessel (hydrometer immersion tube, price about 1s. to 2s.), so as to fill it to the top within an inch or so. The hydrometer is then lowered (heavy end downward) into the fluid, and at a certain position it is found just to balance or "float." The line where the surface of the liquid cuts the scale on the instrument is the degree of saturation according to that particular form of instrument. A saturated solution of iron perchloride usually reads about 45°. For our first experiment it will be well to be provided with three glass "one pound jam jars." Having prepared enough of the saturated solution to about half fill the jar, its density is tested as just described, and the vessel marked with a label or paint 45° B. The second solution is prepared by diluting some of the saturated solution with water, adding only a little at a time until it reads 43 on the scale, and this is, of course, labeled 43° B. In like manner the third vessel should contain a 40° B solution.

(To be continued.)

* To give some idea of prices, etc., for country readers, a dozen cut pieces, 4¼ × 3¼ sensitized, i. e., ready for printing, cost about 6d. It may be had from Elliott & Sons, Barnet, or the Autotype Company, New Oxford Street.

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6698
7085
7053

6827
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6999

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6779